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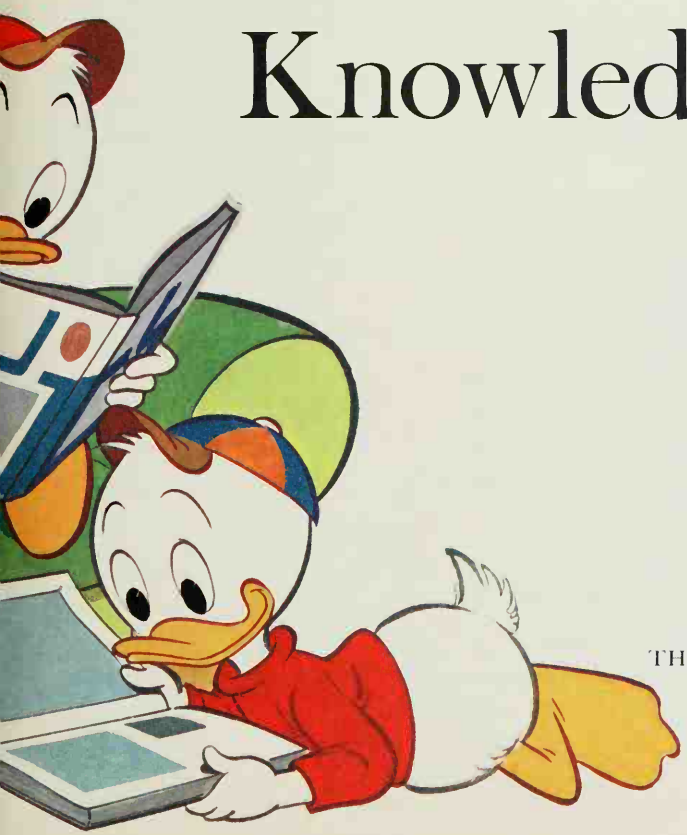
Disney's Wonderful World of Knowledge



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MEN IN SPACE

Boys and girls, allow me to introduce myself. I am the famous scientist, Professor Ludwig von Drake. And I have been chosen to take you from the past into the astonishing world of the future. I am going to tell you how man, with his great inventiveness and genius, has conquered many of the mysteries of the universe, and, as you well know, has even set foot on the moon!

You may ask, "Why should we spend billions of dollars and risk human lives just to go to the moon? Why should we leave earth?" These are good questions, for the earth is indeed a very fine place. However, if man did not have his great curiosity, did not thirst for knowledge, and did not wish to explore the unknown, we might still be living in caves.

Just as an experiment, I once tried to live in a cave for a whole week. I ate only roots and slept on a hard block of granite. I can assure you that it was no fun at all!

Therefore . . . now what was I saying? You will have to excuse me. I am a little absentminded, as most great persons are. Ah yes, I remember. I will begin my story by telling you about man's achievements in outer space.

WHAT A BLAST!

Perhaps some of you boys and girls have heard of Jules Verne (1828–1905), the famous French science-fiction writer. In his stories, Verne showed a remarkable ability to look into the future. But this ability was based on his knowledge of new scientific discoveries and theories. For he spent hours reading scientific books and research papers.

In 1865 Verne wrote *From the Earth to the Moon*, about three men who journeyed to the moon. He wrote of a bullet-shaped moon ship and chose Florida as the best location from which to launch it. But most amazing was the way he launched his moon ship. It did not just fly off the face of the earth. An enormous cannon was used to launch it. Today, of course, a rocket is used to launch a spacecraft into orbit. But imagine—100 years ago—Verne foresaw the use of a launch vehicle for spaceflight.

A rocket is really an engine that can supply power to anything that must be propelled—an automobile, a satellite, or a spacecraft. A rocket can be thought of as a tube filled with fuel that is open at one

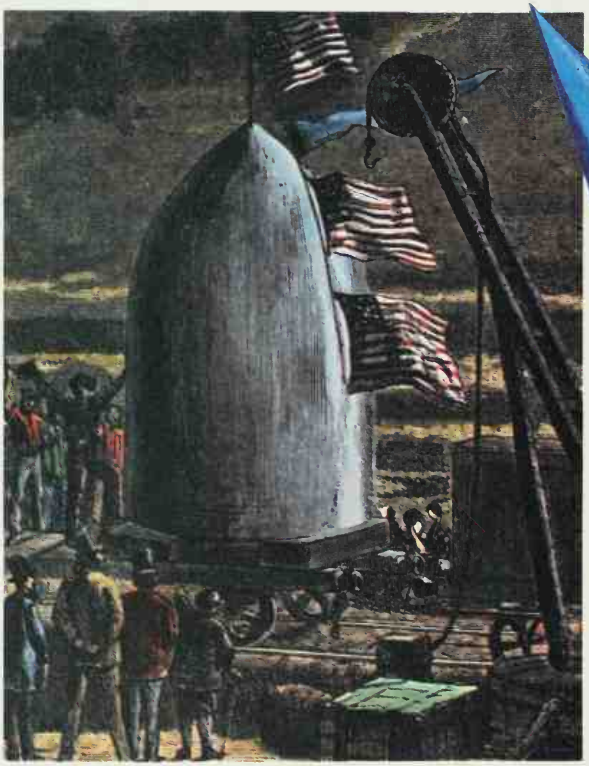
Above: British soldiers experimenting with a new kind of rocket in the middle of the 19th century. Battle accounts written hundreds of years ago describe primitive rockets in use as early as the 8th century.
Below: The 19th-century writer Jules Verne predicted the design of the space capsule of the future with amazing accuracy. This lunar capsule, described in Verne's book From the Earth to the Moon, *was designed to carry three astronauts. A fascinating coincidence is that Verne placed his launching pad near Cape Kennedy, Florida.*

end and closed at the other. When the fuel burns, it becomes a gas. The hot gas expands and rushes out of the open end of the rocket. This action causes the tube to move in the opposite direction. The faster the gas rushes out, the faster the tube will move.

In 1903 Konstantin Tsiolkovsky, a Russian scientist, published the first scientific paper on the use of rockets for spaceflight.

Several years later two other scientists, known as "the fathers of spaceflight," began their work in the field of rocketry, independent of each other. They were Hermann Oberth of Germany, and Robert H. Goddard of the United States.

Goddard began to work on a new rocket—one that would use liquid-fuel.



The development of a rocket capable of exploring outer space and traveling to the moon resulted from the work of many scientists from all over the world. The studies of the German Hermann Oberth and the Russian Konstantin Tsiolkovsky added important new information to the field. The American scientist Robert Goddard (pictured below) launched the first successful liquid-propelled missile in 1926. Goddard's missile consisted of a 2 foot motor attached to a 10 foot metal tube. It rose to a height of 41 feet.

This was a revolutionary concept, because until that time, gunpowder had been used as fuel. Goddard thought that liquid-fuel would be more powerful than gunpowder. He was right, and in 1926 the first liquid-fuel rocket was launched.

Eventually enormous rockets were developed, made up of several rockets mounted on top of one another. As each rocket burned and was emptied of its fuel, it would be castoff. Thus we have our launch vehicle—several rockets powerful enough to send a spacecraft or satellite beyond earth's atmosphere.

Now boys and girls, we are on our way into outer space!

The Soviet launching vehicle Vostok 1 was used for the first earth orbit in 1961. The cosmonaut who accomplished this feat was the 26 year old air force major Yuri Gagarin.

The huge rockets of the Soviet Vostok series were about 125 feet high and weighed over 5 tons. They were equipped with 20 motors, some of which are shown here. The first Vostok consisted of a two stage central rocket surrounded by four other rockets mounted on the lower part of the first stage.

INTO THE SPACE AGE

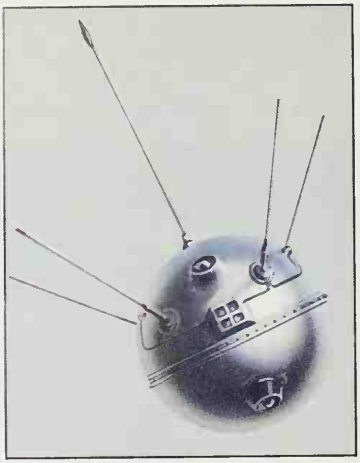
On July 29, 1955, the United States announced that it was planning to orbit an artificial (man-made) satellite that would circle the earth. It would be used to study the earth's upper atmosphere. This was important news and further developments were closely followed.

Then the unexpected happened. On October 4, 1957, the Soviet Union announced that it had launched the world's first artificial earth satellite. Called Sputnik 1 (meaning satellite in Russian), it weighed about 184 pounds. With its successful launching, the world entered the Space Age.

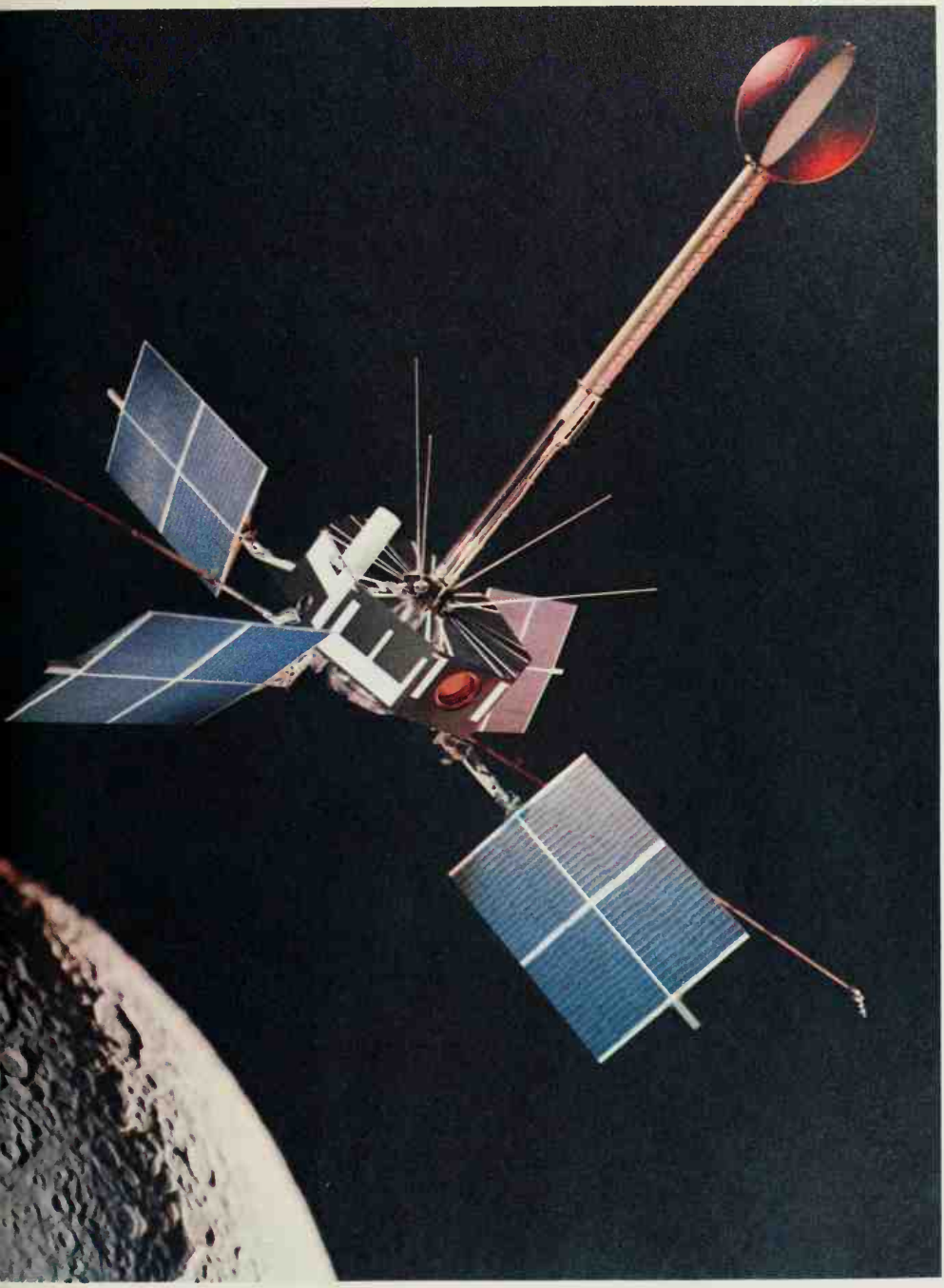
That launch also began the space race between the United States and the Soviet Union. On January 31, 1958, the United States orbited its first earth satellite, Explorer 1. A Jupiter rocket was used to launch it. The whole project had cost some $20,000,000.

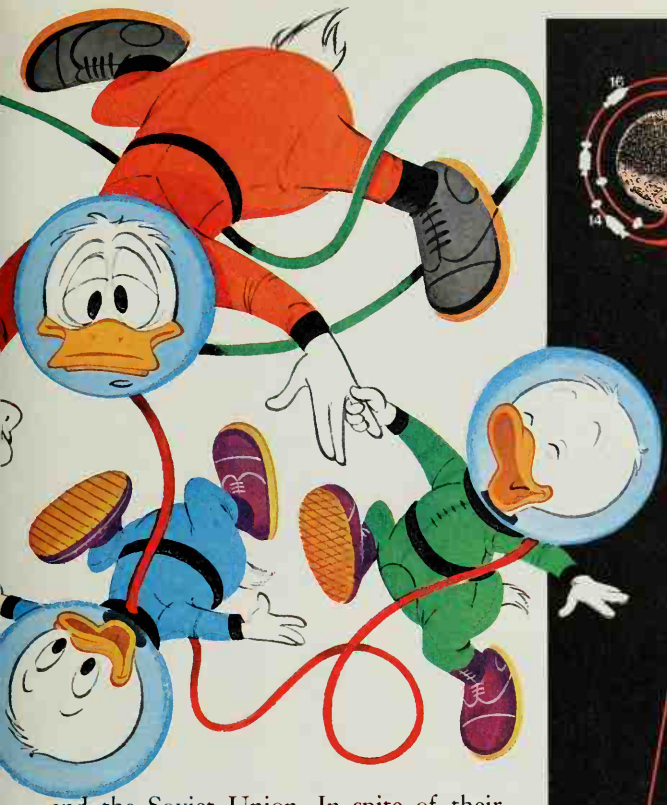
Just imagine the gulps, quacks, and grunts of Uncle Scrooge when he read in his borrowed newspaper about this "waste" of money!

More satellites were launched, one after the other, both by the United States



In 1959 Soviet scientists succeeded in launching a man-made satellite that reached the surface of the moon. The vehicle (left), named Luna II, landed near the moon crater Archimedes and crashed on impact.
Its predecessor, Luna I, was the first man-made satellite to escape the earth's gravitational field and go into orbit around the sun.

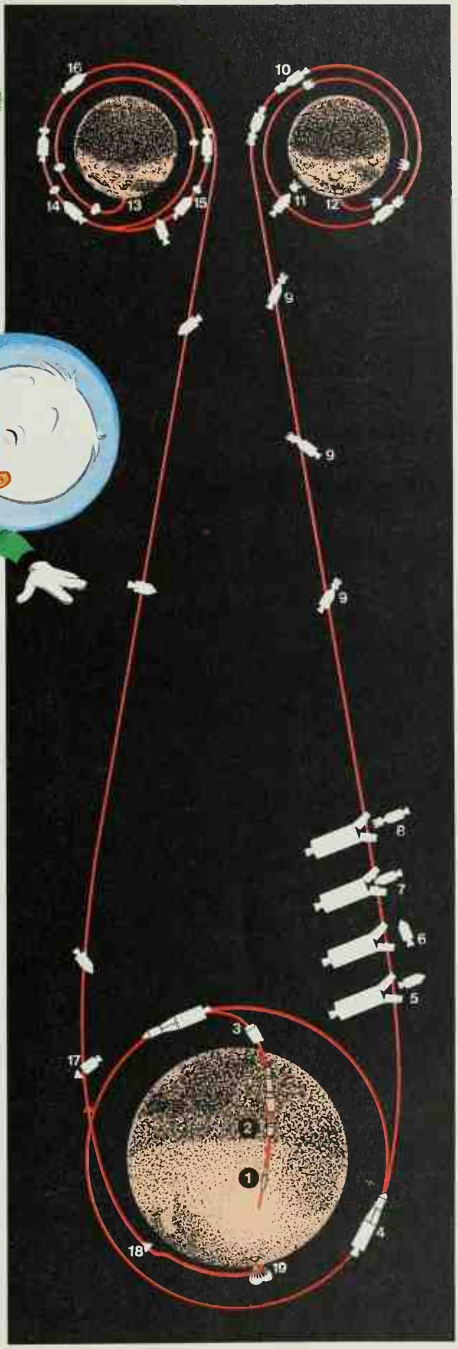


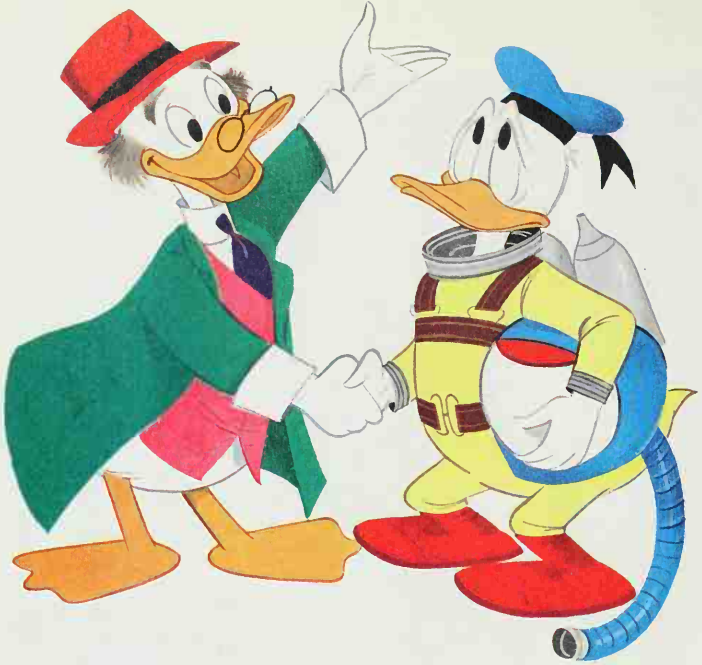


and the Soviet Union. In spite of their high cost, these satellites have provided us with a wealth of information.

Today we have weather satellites that can photograph clouds and warn us of tornadoes and hurricanes. Aircraft and seacraft can receive data from navigational satellites that will help them to steer along safe courses. Radio and television signals

Opposite page: Edward White was the first American to "walk" in space. In June, 1965, White left the spacecraft Gemini 4 and maneuvered by releasing short bursts of oxygen from the jet gun in his hand. Beneath him, about 125 miles away, lay the Pacific Ocean. Four years later the Apollo 11 traveled to the moon and men walked on its surface for the first time. The American astronauts Neil Armstrong and Edwin Aldrin Jr. were the first men to accomplish this feat.
Right: A diagram of the path of Appolo 11.





can be sent, even from one continent to another, by means of communications satellites. Military satellites are used to photograph possible enemy activity. Still other satellites have provided astronomers with new and even startling information about the earth and its upper atmosphere.

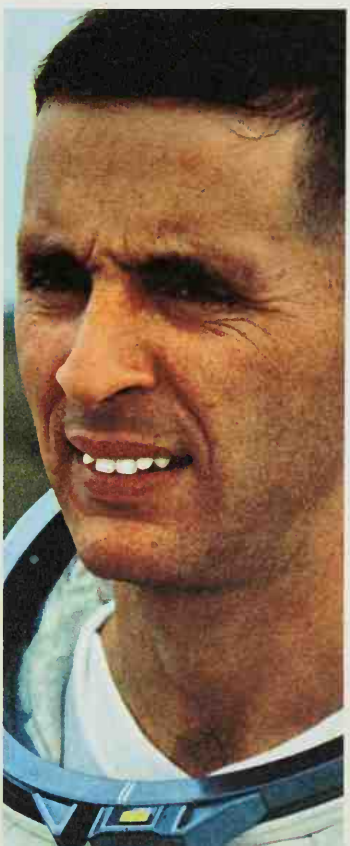
And the satellites of the future promise even greater rewards.

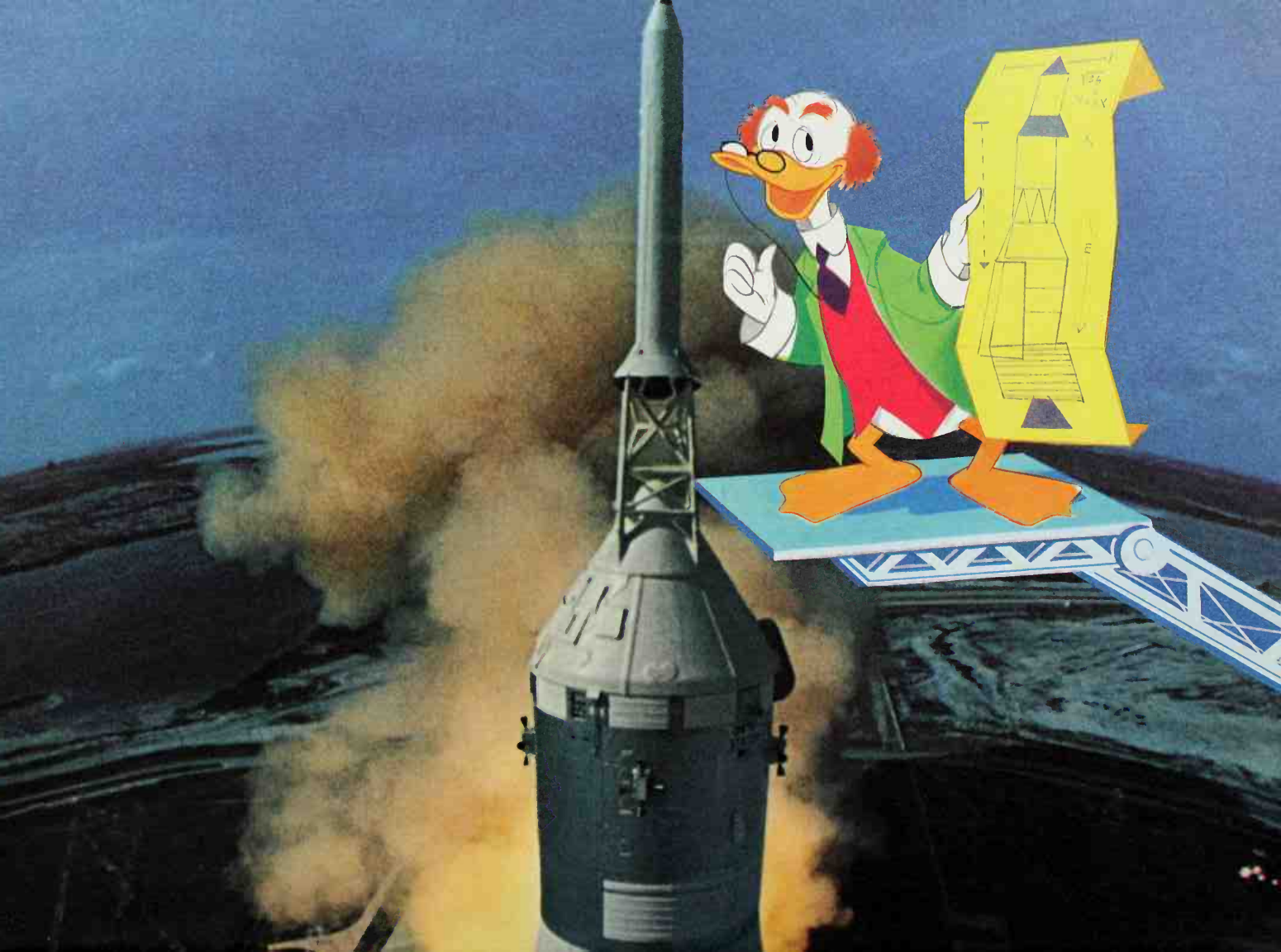
MAN INTO ORBIT

Unmanned satellites were now part of space history. Could we take the next step forward and add a man to the machine? Although experiments with animals proved that a manned spaceflight was possible, no one could be sure how long a man could live and work within a spaceship.

The United States began to train astronauts as future space travelers. Project Mercury would see a manned space capsule thrust into space for a brief trial flight and recovered at a given spot. If that was

Many men took an active part in the efforts to conquer space. Some of them are pictured here. On the opposite page is the Soviet cosmonaut Yuri Gagarin, first man to orbit the earth. Left: Lt. Col. John Glenn, the first American to orbit the earth. Below, from left to right: Frank Bormann, James Lovell, and William Anders. The three American astronauts took off from Cape Kennedy on December 21, 1968, aboard Apollo 8. They were the first men to circumnavigate the moon. On the following pages is a photograph of the gigantic Saturn 5 missile as it blasted off from Cape Kennedy. It took 3 seconds for the huge space missile to leave its launching pad and 8 seconds to reach a height of 15,000 feet. At this stage the weight of each astronaut had increased about four times.





successful, a complete orbit of the earth would be attempted.

But a Russian, Yuri Gagarin, was to have the honor of being the first man in space. On April 12, 1961, Gagarin orbited the earth in the spacecraft Vostok 1.

In the United States, Alan B. Shepard, Jr. made a 302-mile flight in the Mercury capsule, Freedom, on May 5, 1961. John H. Glenn, Jr., aboard the Friendship 7, orbited the earth three times on February 20, 1962.

There was no holding back now. All aboard! Next stop—the moon!

APPOINTMENT IN SPACE

There were still many questions that had to be answered before the big trip. The United States and the Soviet Union were at work improving their spacecraft and testing the ability of men to live in space for longer periods of time.

July 20, 1969, was one of the most important days in the history of mankind. On that day man set foot on the surface of the moon for the first time. Neil Armstrong's footprint, indelibly imprinted because of the absence of wind and rain, remains as a permanent reminder of the event.

Above: The three astronauts who made the Apollo 11 flight to the moon. Left to right, Neil Armstrong, Michael Collins, and Edwin Aldrin Jr. Opposite page: Model of a space station.

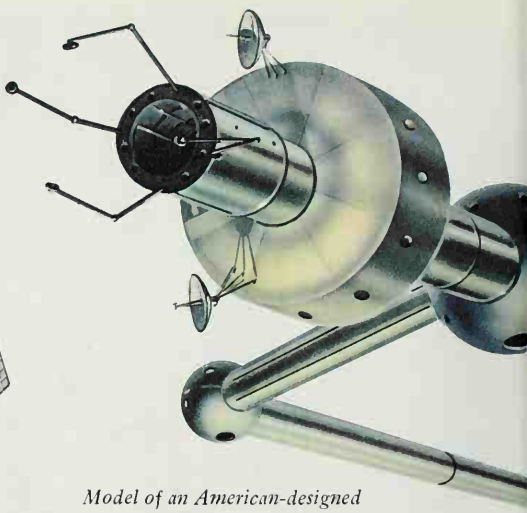
In the next years, not one, but two and then three men traveled in one spacecraft. Men walked in space while still connected by cable to the ship. Two orbiting vehicles met and docked at a given hour and at a given point in space.

The reward for all the careful planning and the gathering of information came on July 20, 1969. Neil A. Armstrong was the first man to set foot on the moon's powdery surface. He was followed out of the Apollo 11 lunar module by Edwin E. Aldrin, Jr. The command module in lunar orbit 70 miles above was piloted by Michael Collins.

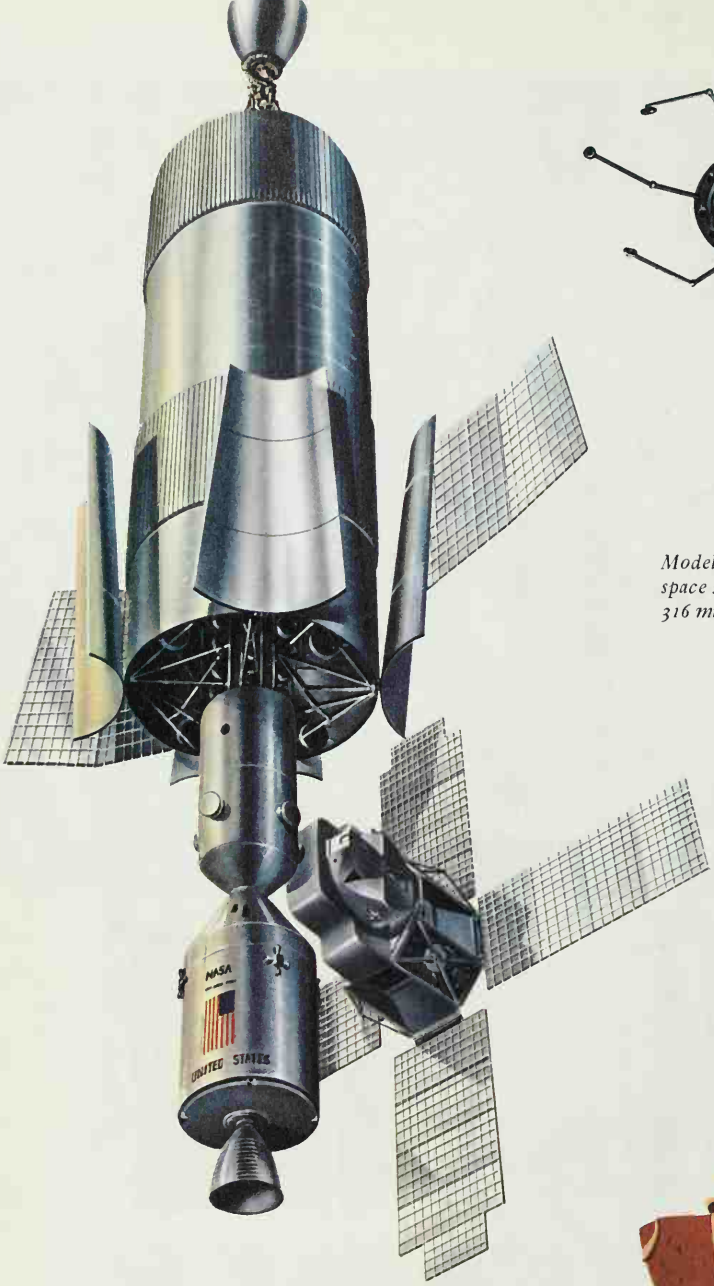
Wheeled vehicles now travel over the surface of the moon. The Russians sent the radio-controlled Lunokhod in 1970. American astronauts brought a moon rover with them on a 1971 moon landing.

STATIONS IN SPACE

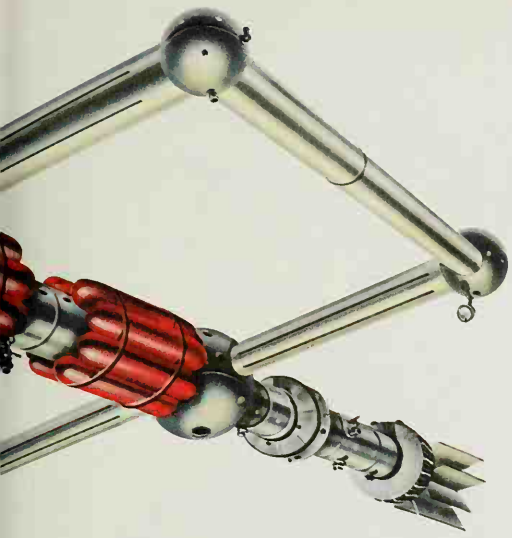
We held our breath in amazement and suspense during many moments of the space missions I described. But my dear young friends, we now see that these tremendous trips were only a first step, a modest beginning of a longer journey. We were only stretching our legs before



Model of an American-designed space station that will orbit at 316 miles above the earth.



Design of Skylab, a space laboratory of the future. Living area and laboratory are in large section at top. Command and service modules are at bottom, marked by U.S. flag. In between is an adapter with solar telescope attached at left. Four panels of solar batteries extend from telescope.

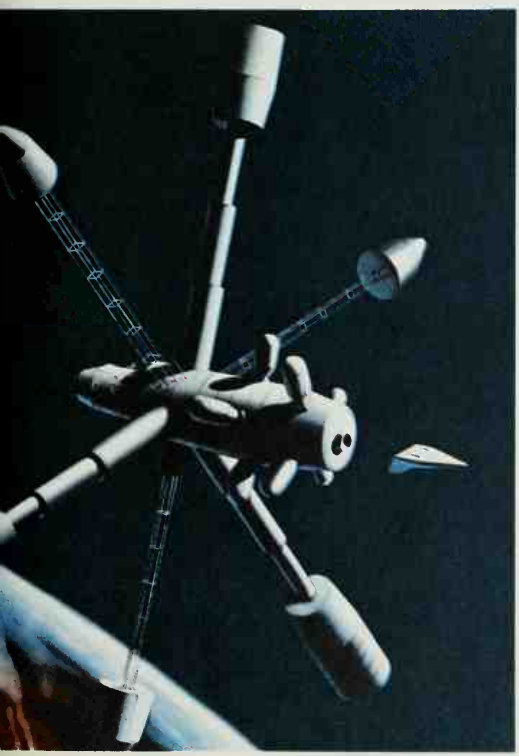


setting out on a road that will take man to other planets and even outside our own solar system.

For such long trips, scientists plan space stations that will orbit the earth. These stations will provide launching sites from which future spacecraft will set off towards distant worlds.

Plans have been made for stations built from prefabricated sections launched into orbit. Spaceships will bring men especially trained for such work to the appointed spots. There they will gather and assemble the sections. They can also assemble

Permanent space stations, like those in the paintings below, will be placed in orbit around the earth in the future. Fresh supplies and replacement crews will be sent aloft from earth every few weeks, probably in rocket-powered space shuttles.



Above: Freedom 7, the space capsule in which Alan Shepard made the first manned U.S. space flight. Opposite page: Space capsule with hatches open showing a glimpse of the interior.

spacecraft from parts rocketed from earth.

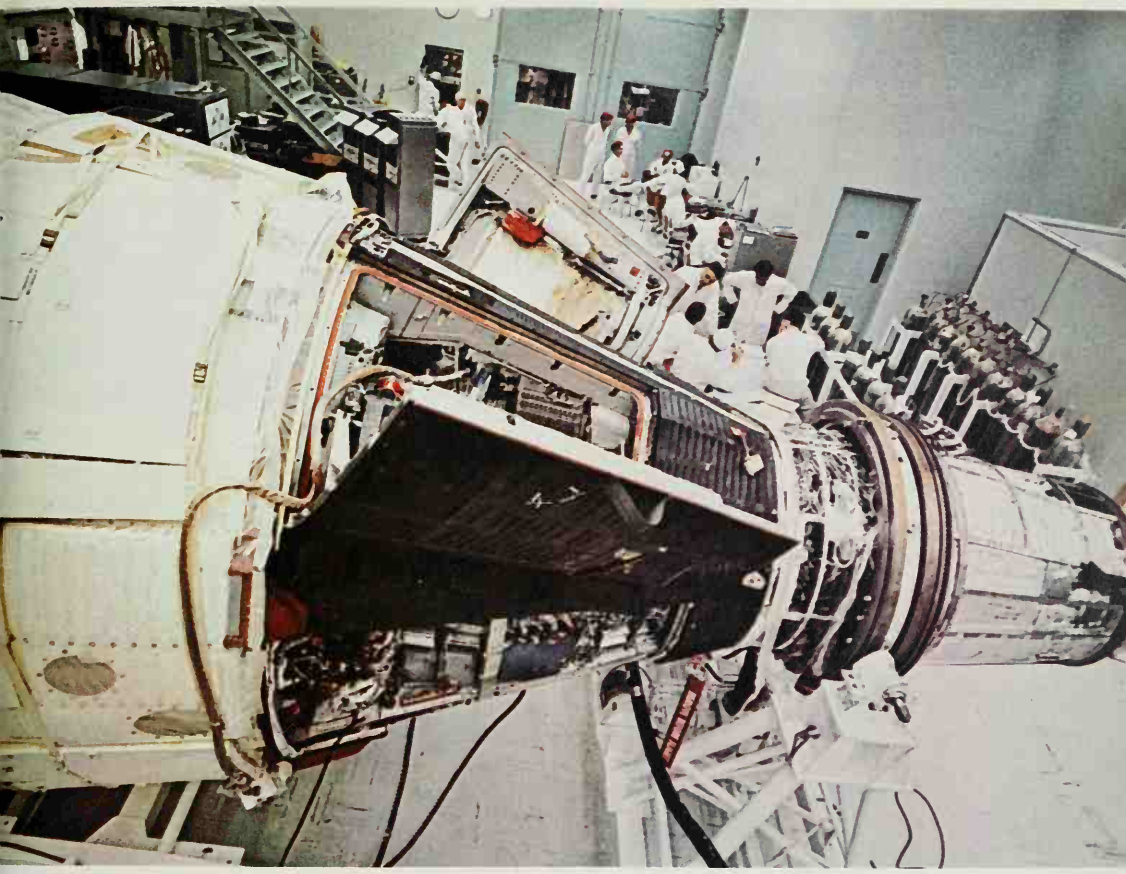
Shuttles that are launched from earth will carry a change of crew and supplies to the stations. The stations will also serve as space and astronomical observatories for collecting new information.

Arranging for space to store fuel and supplies for a long voyage is a major problem of astronautics. Spaceships flying at their present speed would take many months to reach the nearest planet and to return to earth. There must be enough fuel stored for the return trip of a manned voyage, so you can see why it is essential to find ways to save storage space.

A launch from a space station will make a great saving of fuel because a blast-off from earth requires an enormous amount of fuel just to overcome the earth's gravity.

VENUS OBSERVED

Space probes have given scientists a wealth of information that can be used in further programs. Unmanned vehicles carrying instruments of every kind send back photographs and scientific data. Terrestrial (earth) probes explored the space



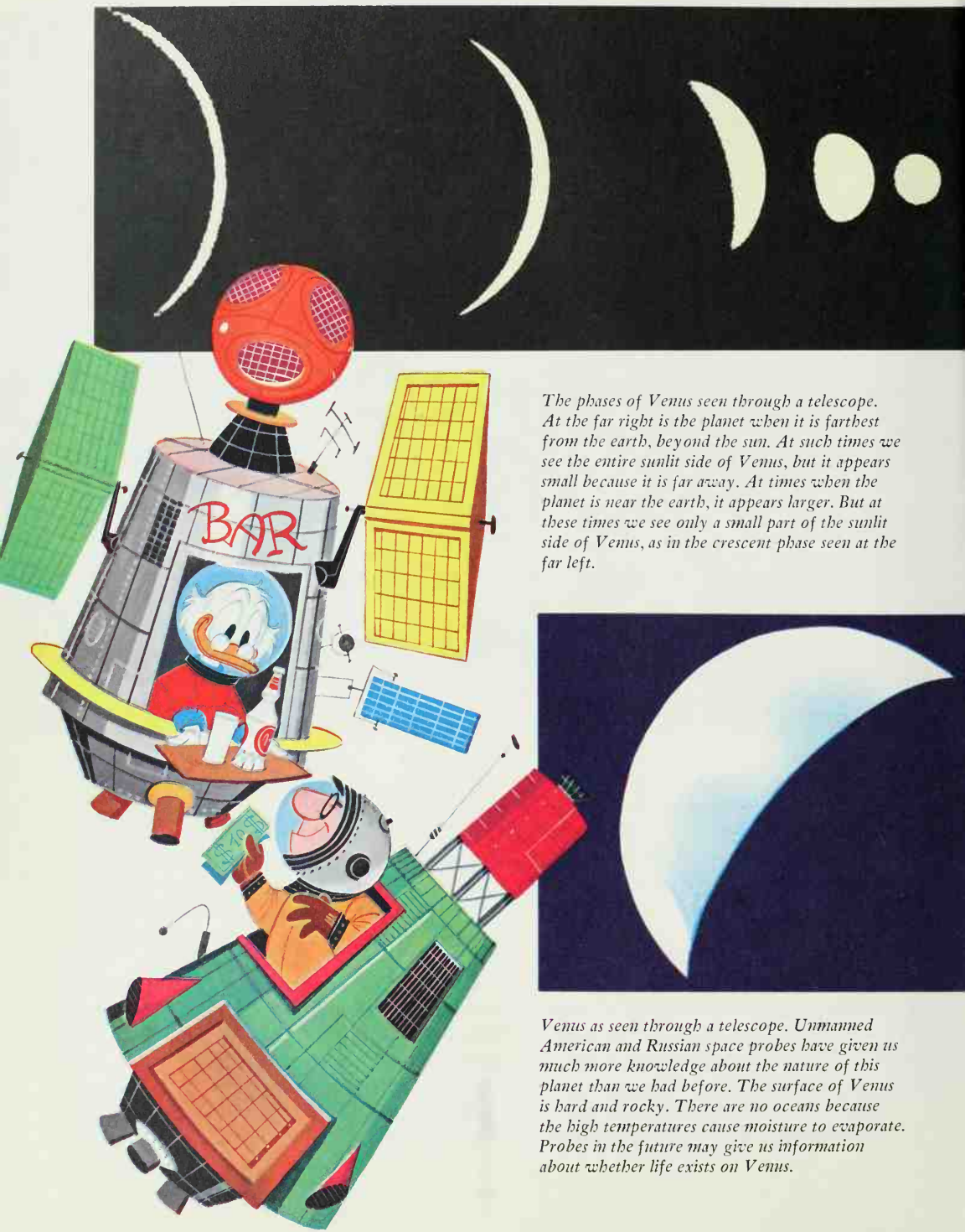
regions around the earth. Lunar (moon) probes made the Apollo 11 landing possible. Probes have been sent to three other planets. Plans have been made to inspect every planet and also to study interplanetary space.

The first planetary probes were launched to Venus. Venus approaches the earth more closely than any other planet. Just to give you an idea of what "closely" means in space, Venus sometimes comes within 26,000,000 miles of earth!

Astronomers have always found it difficult to observe Venus because the planet is wrapped in an apparently unbroken mass of clouds. Radio astronomy brought a little information about Venus. Huge computers told us that Venus rotates from east to west. If we ever reach this planet, we might be a little confused to find the sun rising in the west and setting in the east.

The Soviet Union sent the first Venus probe on February 12, 1961. It was directed by radio from Sputnik 8. It bypassed Venus by a large margin and was lost forever in space.

The United States probes, Mariner 2 and Mariner 5, launched in 1962 and



The phases of Venus seen through a telescope. At the far right is the planet when it is farthest from the earth, beyond the sun. At such times we see the entire sunlit side of Venus, but it appears small because it is far away. At times when the planet is near the earth, it appears larger. But at these times we see only a small part of the sunlit side of Venus, as in the crescent phase seen at the far left.

Venus as seen through a telescope. Unmanned American and Russian space probes have given us much more knowledge about the nature of this planet than we had before. The surface of Venus is hard and rocky. There are no oceans because the high temperatures cause moisture to evaporate. Probes in the future may give us information about whether life exists on Venus.

American space probe Mariner 6 photographed during its journey toward Mars in 1969. The probe passed within 2,100 miles of Mars and sent back many photographs of the planet's equatorial region. Mariner 7, which passed Mars only a few days later, photographed the icecapped south polar region, with some of the most rugged terrain ever seen nearby.

1967, passed near the white globe of Venus. They sent back temperatures and other readings. Additional information was transmitted by the Soviet Venus Probes 4, 5, 6, and 7 in 1967, 1969, and 1970.

We have learned a little more about Venus. Its atmosphere is made up of 90 to 95 percent carbon dioxide. There is little nitrogen and very little water vapor or oxygen. The atmospheric pressure on Venus is enormous. Surface temperatures may be as high as 800 degrees Fahrenheit.

Is there any life on Venus, or is it a huge, gloomy desert? Perhaps there is a form of plant life. The next years may not tell us all the answers, but you can be sure they will yield more information.

PROBING MARS AND JUPITER

Mars, like Venus, has been the target of space probes by the United States and the Soviet Union. The American explorations furnished the most information.

Mariner 4 transmitted the first photograph of the surface of Mars in July, 1965. Mariners 6, 7, and 9 sent back additional photographs and information.

On March 2, 1972, the United States launched a spacecraft that will make the longest voyage since the beginning of the Space Age. Pioneer 10 will take 21 months to reach the planet Jupiter. In December, 1973, it will take the first close-up pictures of this huge planet, which is 318 times as large as earth.

From Jupiter, Pioneer 10 will fly beyond the outermost planet and escape our solar system in 1980. No spacecraft has ever flown so fast. Imagine, it passed the moon in 11 hours as compared to the 2½-day flight of the Apollo 11.

Since it is possible that some distant civilization out there in space may meet the spacecraft, Pioneer 10 contains a plaque with drawings and symbols of its origin. We hope that an advanced civilization will be able to decode the message.

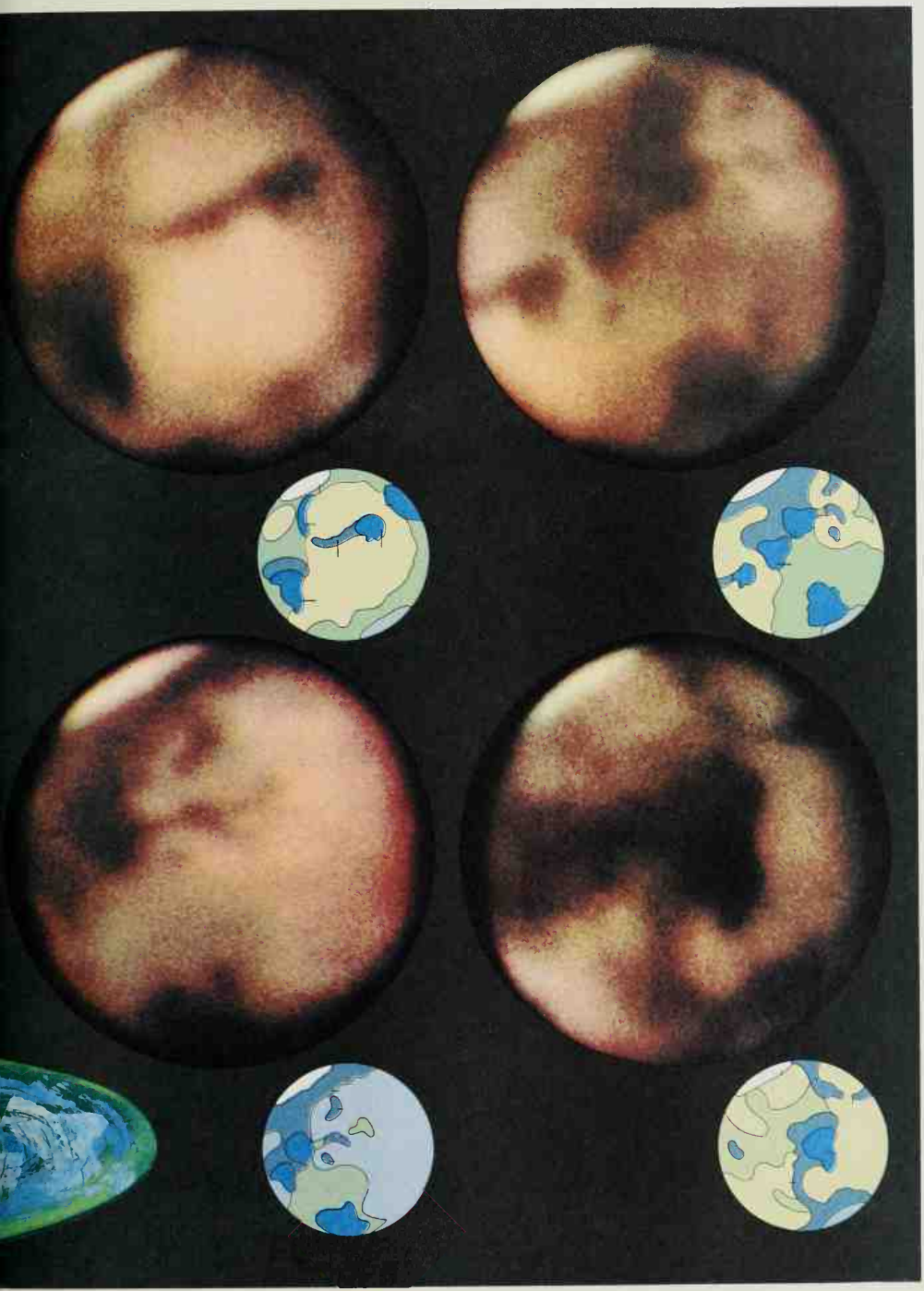
LONG, LONG JOURNEY

We are planning even longer journeys. A spaceship traveling at 100,000 miles an hour would probably take about 4 years and 3 months to reach the planet Pluto. But how long would it take to pass through our galaxy, the Milky Way? Flying at the speed of light—186,000 miles per second—it would take 80,000 to 100,000 years to get there and not quite so long to return.

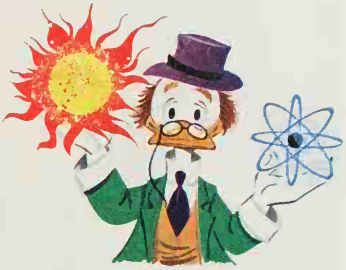
Scientists have many ideas of how we can make this trip. I like one that proposes the building of gigantic spaceships. The ships would travel at a speed almost equal to the fantastic speed of light. Whole families would board these ships to begin a voyage that would be completed by their descendants. Can you figure out how many generations it would take to complete this extraordinary adventure?

Would you be willing to take the risk? Great! I, Ludwig von Drake, will be your guide when the time comes.

Opposite page: Four photographs of Mars with accompanying drawings showing the planet's rotation (turning on its axis). The turning of the planet can be seen by the change in position of certain surface features from one photograph to the next.



THE STORY OF ENERGY



Once upon a time—hundreds of thousands of years ago—early man saw lightning strike a tree. The tree burst into flame. The man, although frightened, did not run away. Instead, he broke off a branch of the burning tree to examine the mysterious flickering flame that lit up the darkness. He noticed that the flame provided heat.

This is not one of Ludwig von Drake's scientific fables, boys and girls. It is the story of one of the major discoveries of all time. In fact, the discovery of fire was one of the most important steps in the development of civilization as we know it today.

Fire is used as a primary source of energy. Would you like proof? Place a pot of water on the stove and bring it to a boil. Watch the lid. It will slowly begin to move and bounce about until it practically jiggles right off the pot!

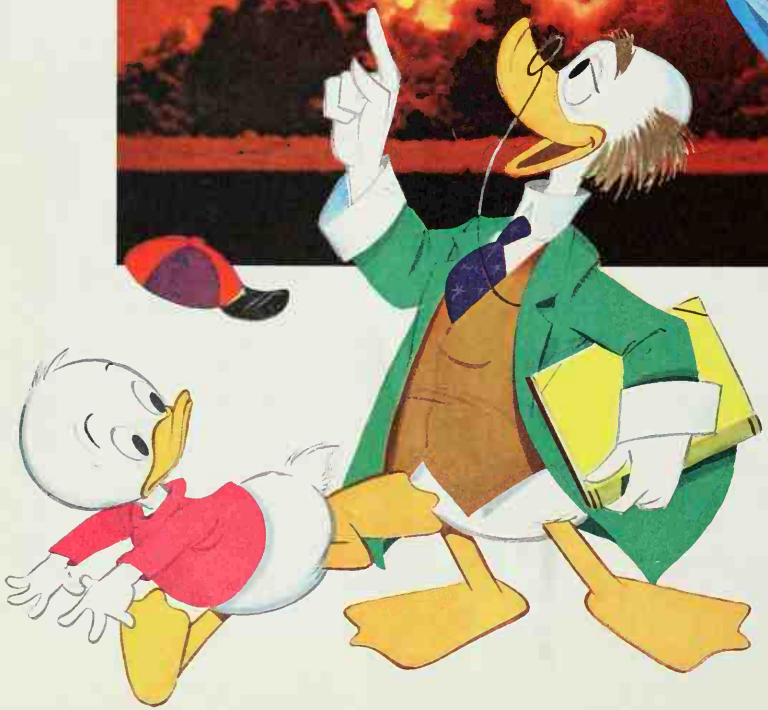
NEW SOURCES OF POWER

Let's look at our experiment one step at a time. The fire made the water boil. Some of the boiling water turned into steam, which expanded and produced the energy that shook the lid.

Believe it or not, my friends, but the energy in expanding steam is used to operate the steam locomotive as well as electric generators and turbine engines. The heat that produces the steam to run these machines usually comes from burning fuel, such as coal, wood, or gasoline.

Nuclear reactors can also furnish the heat to produce steam. In nuclear reactors, the nuclei of radioactive material are split, or broken apart. This action creates an enormous amount of heat energy. This energy is used to produce steam, which in turn is used to power huge electrical generators or machines.

Because much of the energy that is used in industry comes from burning coal and petroleum, we are faced with two major problems. Gases and waste matter from the burning fuel are slowly poisoning our air. It is becoming more and more dangerous to breathe. The other problem has to do with our reserves of coal, petroleum, and natural gas. Because of the worldwide demand for these fuels, our supplies are rapidly disappearing. So, in recent years, man has turned his attention to finding new sources of energy. There are three possibilities: radiation from the sun, radiation from the earth's interior,



Above: The first explosion of a hydrogen bomb took place in 1951. The most powerful explosive device ever produced, its energy comes from the fusion of atoms of hydrogen. The fireball that results from the explosion measures 3½ miles across. Gradually the fireball boils into a mushroom-shaped cloud. Right: Scientists are attempting to exploit the sun's energy through the use of solar furnaces. The one pictured here is located in Mont-Louis, France.

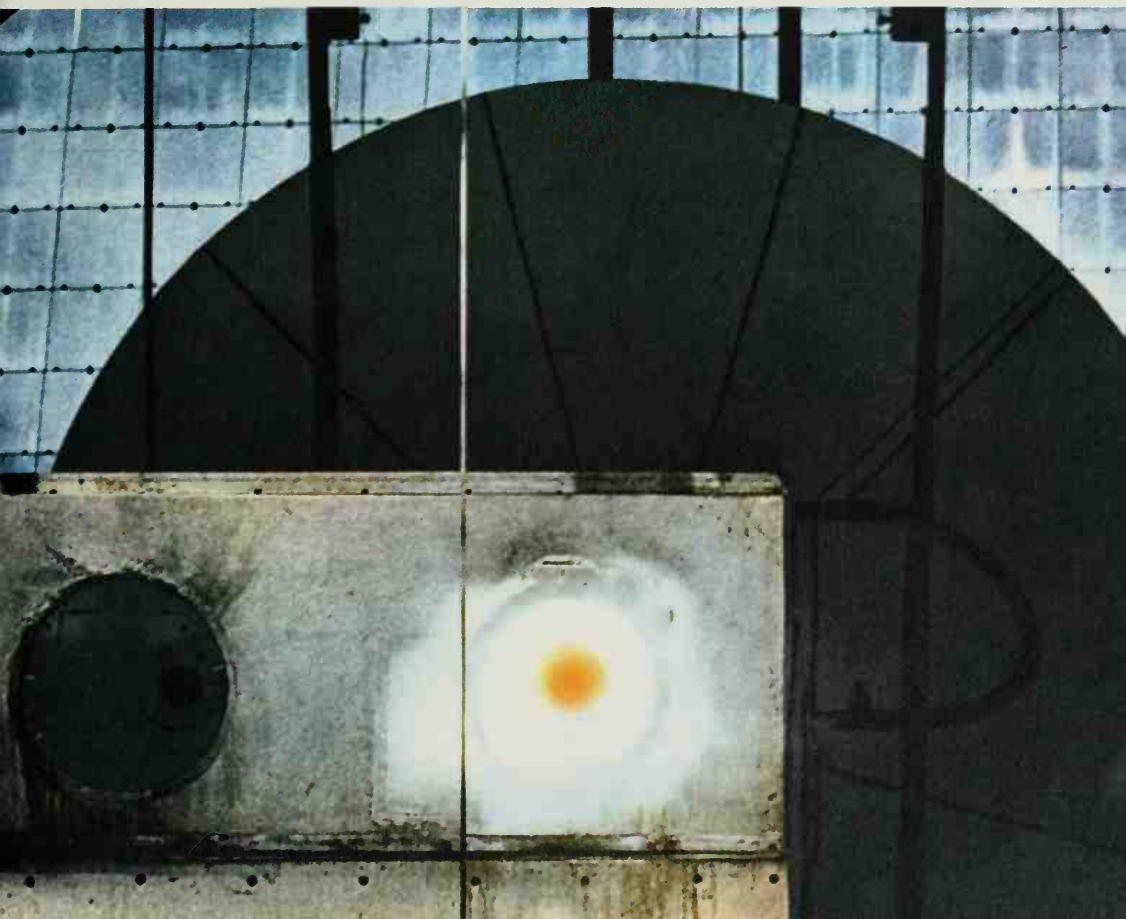
and nuclear radiation. Don't be frightened by these terms, boys and girls. I, Ludwig von Drake, great scientist that I am, will explain them to you.

WONDROUS MIRRORS

The use of solar radiation, or radiation from the sun, was attempted by Archimedes, a Greek mathematician and inventor who lived some 2,200 years ago. Using mirrors, Archimedes demonstrated some of the ways that the heat of the sun could be controlled by man. There is a legend that he used a bronze-curved mirror to focus the rays of the sun on a fleet of Roman ships that attacked his homeland. The heat of the sun reflecting off the mirror set fire to the enemy's ships, destroying the entire fleet.

Archimedes' principles were used in the 18th century by the French naturalist, Georges Buffon. After conducting experiments with various constructions of mirrors, Buffon was able to set fire to a pile of wood from a distance of 200 feet.

However, man has not always been successful in his attempts to harness solar energy. You see, my friends, the sun does not send a great amount of energy to any one place at any one time. The energy is spread out over vast areas. So, through



the years, engineers built a number of devices to collect solar energy in one place. One of the first solar furnaces was constructed by the California Institute of Technology. In place of mirrors, the furnace used lenses to concentrate the solar light.

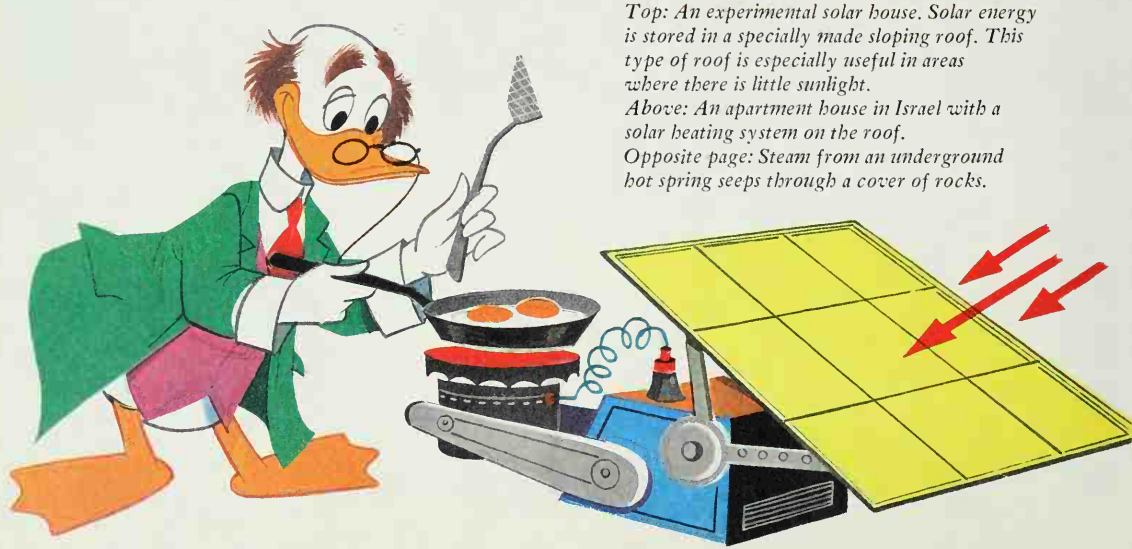
Unfortunately, this highly complex instrument was very expensive to build and not very successful. Engineers continued to work, however, until they developed a more simple instrument that could harness the sun's energy. Today a solar furnace successfully operates in the Pyrenees mountains in France. A similar type of solar furnace has also been constructed in Denver, Colorado.

STORING SUNSHINE

How often, on a beautiful summer day, have you said to yourself, "Ah, if only I could store this delightful warmth to use on those cold winter mornings!" It sounds strange, doesn't it—storing heat, just as we would can vegetables in the summer to eat during the long winter months.

Well, my friends, it really isn't as strange as it sounds. Scientists have conducted many experiments in which stored solar energy actually heats homes. One of

Top: An experimental solar house. Solar energy is stored in a specially made sloping roof. This type of roof is especially useful in areas where there is little sunlight.
Above: An apartment house in Israel with a solar heating system on the roof.
Opposite page: Steam from an underground hot spring seeps through a cover of rocks.



the more successful demonstrations made use of a metal sheet, called a flat-plate collector. The collector is placed on the roof of a house. Pipes carrying water are attached to the underside of the flat-plate collector. Heat from the sun's rays warms the collector, which in turn, heats the water. The water circulates from a storage tank, through the collector pipes and flows back to the tank. The hot water is then stored in the tank until winter when it is piped into radiators in the house.

It was found, however, that in most experiments solar energy provided only half of the heat that the house required. Most homes need a regular heating system to supply the rest of the necessary warmth.

Sunlight is also being used to produce electric power. The device that turns the sun's rays into electricity is called a photoelectric cell. When light shines on these cells, an electric current is produced. If sunlight is used, the cell is called a solar cell. Many of the cells are connected to make a solar battery, an instrument that is extremely useful in supplying electric current for spacecraft.

GEYSERS OF ENERGY

Our very own planet is also the source of an enormous reserve of heat-producing energy. This energy is hidden deep within the several layers of the earth. It is brought to the surface by volcanoes, hot springs, and geysers.

Ordinarily we think of volcanoes as large cone-shaped mountains that send flames, gases, and rocks flying into the air. Did you know, however, that there are some volcanoes that don't shower us with rocks and scalding lava. I, Professor Ludwig von Drake, have it on very good authority that some large volcanic eruptions release a most valuable substance: huge amounts of energy in the form of steam and heat. Man, however, has been able to control and use only a small part of this energy. In some countries volcanic steam is used to generate electric power and produce chemicals such as boric acid. In Italy, for example, an entire system of power plants operates with the help of underground steam. This very same power system also furnishes important raw materials used in the chemical industry.

Hot springs and geysers are other sources of energy. Some parts of the world have natural hot water deep underground. If the water bubbles quietly to the surface, it is called a hot spring. If it erupts high into the air, it is called a geyser. In some countries the hot water and steam are harnessed to make electricity and provide needed heat and hot water. Iceland has many geysers and some of the hottest springs in the world. They are located in the midst of barren lava fields near Reykjavik, Iceland's capital city. Water from this vast network of springs is piped into homes, hospitals, schools,

Opposite page: Engineers have harnessed the steam from a geyser. It will be used to provide electrical power for a nearby town.
Right: When boiling water from an underground stream comes in contact with the surface air, it turns to steam.

and public buildings for hot water and heat.

New Zealand has geysers and hot springs similar to those found in Iceland and Yellowstone National Park in the United States. Engineers in New Zealand, like those in Italy, have built power plants that use steam from underground hot springs to make electricity.

So you see, boys and girls, Mother Earth has many valuable natural resources. When we have learned to control and use them properly, these resources will benefit all mankind.

POWER FROM THE SEAS

I hope I still have your attention, boys and girls, because we're about to discuss one of man's most important sources of energy. So far we've talked about the en-

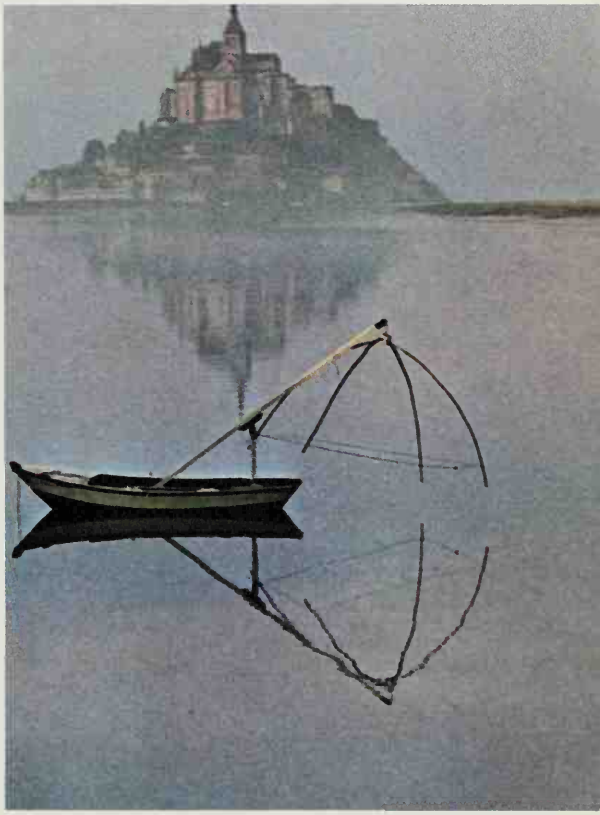
In some areas on the French Atlantic coast, the tides of the ocean are quite spectacular. This is evident in the three photographs of Mont-Saint-Michel. When the tide is out, the island of Mont-Saint-Michel becomes part of the French mainland. As the tide gradually comes in, however, the waters completely surround the island. During this period, the island can be reached only by boat or a mile-long causeway connected to the mainland. Scientists are using these exceptionally high tides to operate a tidal power station on the French coast.

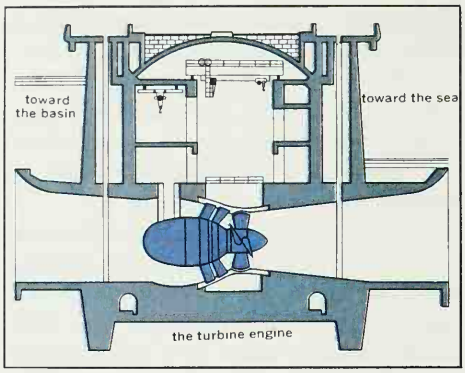
ergy we receive from the sun and the energy hidden deep within the earth. There is, however, another source of energy that has been known to man for centuries. Have you guessed what that source is? If you said "water power," you're absolutely correct. Moving water has always provided man with necessary power, but until recently, man has put this power to very simple uses.

It was not until the late 19th and early 20th centuries that man developed the hydroelectric power plant. With the aid of turbines and electric generators, these plants convert the energy of falling water into electricity! The important thing to remember is that water cannot generate power unless it flows from a higher place to a lower place. That's why most hydroelectric power plants are situated near natural or man-made waterfalls and dams. Today, many of the world's most important waterfalls have been harnessed to generate hydroelectric power.

The vast oceans of our planet are yet another source of hydroelectric power. Each day the level of the ocean water rises and falls. This action, as I'm sure you all know, is called high tide and low tide. Engineers in many countries throughout the world have drawn up plans to harness exceptionally high tides for hydroelectric power.

In 1967, France completed the con-





Sketch of a tidal power station. Water enters the basin during high tide. When the tide recedes, the water falls from the basin, activating the turbine engine. The turbine operates the generator, which produces electricity.

struction of the world's first tidal power station. Basins, turbines, and generators are built into enormous dams. As the tide comes in, the huge basins fill with ocean water. The basins are locked at high tide, and the water is held secure. The basins do not empty until the tide has gone out. When the ocean has receded, the basins are open. The falling water acts as a power force similar to that supplied by cascading waterfalls. The rushing water drives the turbine engines, which in turn operate the generator that produces electricity. Since incoming tides also produce energy, engineers have recently developed turbines that operate by the force created while the tide reaches its high point.

But, my friends, this is only a beginning. As you know, almost three quarters of the earth's surface is covered with water. It is hoped that soon it will be possible to harness all of the energy that is provided by this tremendous amount of tidal activity. Then we may be able to meet the ever-increasing electrical energy requirements needed to run this world of ours.

NUCLEAR ENERGY

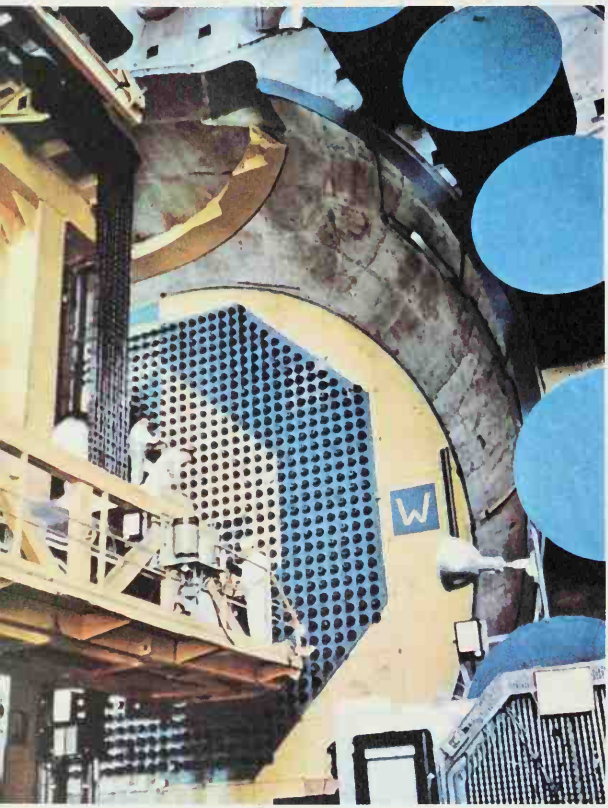
Are your minds alert, my friends? The reason I ask is because I'm going to talk to you about a subject that is somewhat complicated. However, I will try and make it as clear as possible. So just sit back and listen to what Ludwig von Drake has to say. I'm going to tell you about a fairly new type of energy that was only discovered in this century. It is called nuclear energy and is the most powerful form of energy that exists today.

First of all, take a quick look at your surroundings. Everything you see is made up of extremely tiny atoms. These atoms are so small that they can't even be seen under a powerful microscope. The houses, chairs, tables, trees, and air—yes, even your bodies—are made up of a collection of billions and billions of atoms.

Right: A tidal power plant under construction on the estuary of the Rance River in Brittany, France. The construction has since been completed and the plant is able to produce about 450,000,000 kilowatt hours per year.

ON DECEMBER 2, 1942
MAN ACHIEVED HERE
THE FIRST SELF-SUSTAINING CHAIN REACTION
AND THEREBY INITIATED THE
CONTROLLED RELEASE OF NUCLEAR ENERGY

The bronze plaque on the wall of Stagg Field in Chicago commemorates the first chain reaction experiment achieved by man. It was this experiment that made possible the controlled release of nuclear energy.



As small as atoms are, they are made up of still tinier particles. The center, or nucleus, of each atom contains particles of matter. The most important particles are called protons and neutrons. A proton carries a positive charge of electricity, while a neutron has no electric charge. Tiny particles called electrons spin in paths, or orbits, around the nucleus. These electrons are the basis of electricity. In other words, electrons spinning in a stream form an electric current. When a current passes through the filament of an electric light bulb, the movement of the electrons heats the filament to white heat and thus provides light.

Energy can be released from the nucleus of the atom through a process called fission. In this process the nucleus is divided into fragments. When this happens a very small part of the material in the nucleus disappears. Actually, my friends, the material doesn't really vanish—it is transformed into energy.

The splitting of the nucleus of an atom releases neutrons. In a chain reaction, these neutrons then bombard the nuclei of other atoms. As the number of split nuclei increases, the number of neutrons also increases. These, in turn, go on to split other nuclei. A properly controlled chain reaction can furnish enormous amounts of energy.

A controlled chain reaction takes place in a device called a nuclear reactor. By inserting neutron-absorbing rods into the device as well as withdrawing rods from it, scientists can slow down or speed up the chain reaction. If the energy from

Left: An atomic power station located at Marcoule, France. Engineers work at the loading end of the nuclear reactor. The fuel (uranium) is inserted into the holes of the reactor.
Opposite page: The large, round gray structure contains a nuclear reactor. It is part of a vast nuclear power plant situated in Dounreay, Scotland.

the reaction is released slowly, it can be put to work.

Today many of our large power stations use nuclear reactors. A great deal of the energy released is in the form of heat. The heat is used to boil water. Steam from the boiling water is then used to operate a turbine. The turbine drives a generator, which produces electric current.

Nuclear reactors are also a help to us in our fight against certain types of air pollution. Since the energy the reactors produce is caused by nuclear fission rather than the burning of coal or oil, there is no dust or smoke to pollute our air. Unfortunately there is the possibility that nuclear reactors can release small amounts of radioactivity and other pollutants into the atmosphere.

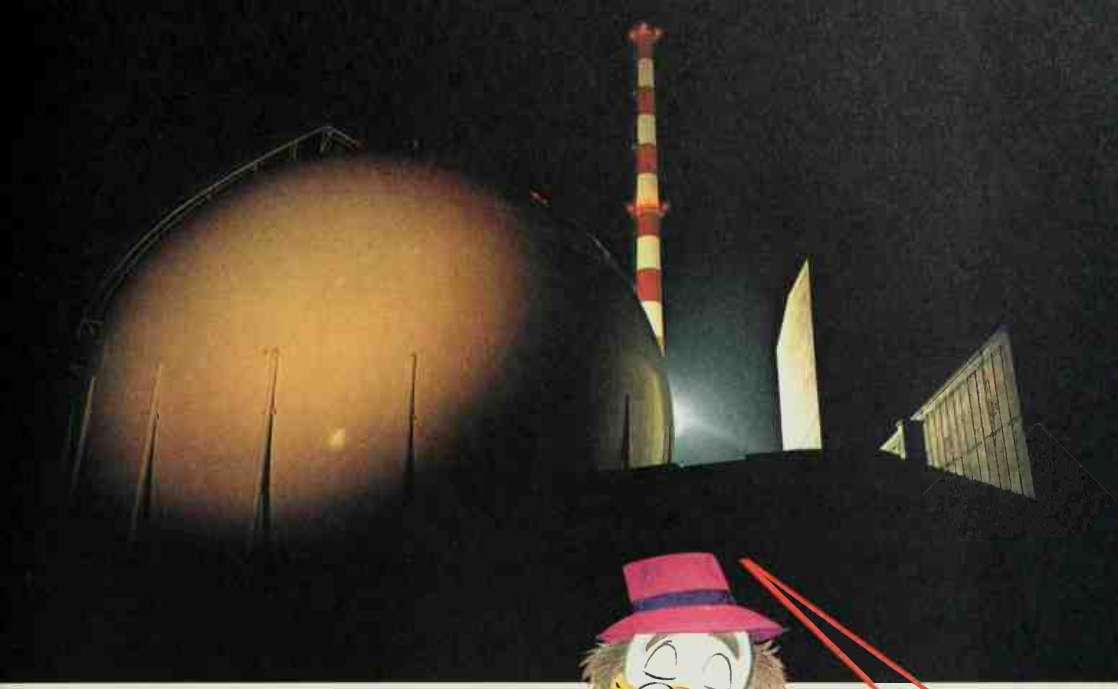
Many countries are turning to nuclear power plants to furnish most of their electric power. This is particularly so in areas where there are few resources for hydroelectric power as well as limited quantities of coal and petroleum.

Nuclear reactors are now used as engines for ships and submarines. The world's first nuclear-powered submarine, the U.S.S. *Nautilus*, was launched in 1954. In recent years scientists have turned their attention to designing nuclear reactors for use in space vehicles.

MAGIC AT WORK

Scientists have developed a new type of reactor. This special device, which produces more fuel than it consumes, is called a breeder reactor. It has many uses.

Suppose we were to install one of these devices on a platform in mid-ocean. The heat produced by the reactor could be used to boil and desalt the seawater. The fresh water obtained in this manner would be pumped back to land and used by the people living along the coast.



You know, my friends, if we were to put all of our scientific and technical skills to good use, there would be no end to our accomplishments.

Above: Sphere containing powerful nuclear reactor.
Opposite page: Part of apparatus assembled inside sphere. The stairs and walkways allow the scientists easy access to the instruments that control the chain reaction set off by the nuclear reactor.

LIVING MEANS MORE THAN SURVIVING

Imagine yourself and your family living in a beautiful, spacious house, with all sorts of modern conveniences created for your comfort and well-being.

What more could you want? Did I hear someone say "Nothing"? That's right!

Now let's go into the kitchen of that beautiful house and open the refrigerator. But what's this? It's almost empty! We'd better do something about that quickly or we'll go hungry. Okay—phone calls to the butcher, the grocer, and the baker should take care of the problem. We won't have to worry anymore about not having enough to eat and drink.

By now I'll bet you've guessed what I'm really talking about. If not, let me explain.

Today man lives in an immense house —the earth—that has been furnished by science and industry with everything we need to make our work easier and our free time more fun. But our beautiful house is very poorly supplied. Its food resources are slowly being exhausted, and its inhabitants are increasing at the rate of about 150,000 per day.

This is already a serious problem. But think of what it will mean in the year 2000—that's less than 30 years from now. Scientists tell us that the population of the earth will have doubled by then. There will be over 7,000,000,000 (billion) people in the world.

This is a huge number of people and their needs will present an enormous challenge. Even today, only one third of the world's people really have enough to eat. The others often lack even the necessities, and they barely manage to survive.

THE WAR AGAINST HUNGER

I'm sure you see that hunger is our greatest and most terrible enemy. We must all do whatever we can to fight it, and everyone must join in the "world war" for survival.

I, Ludwig von Drake, would like to be the general in charge of the battle! I'd plan the attack and issue the orders to our troops on land and sea.

On land, we can achieve victory through using the best irrigation systems,

more and better fertilizers, the most modern agricultural machinery (we're fighting a mechanized war, you know), and new types of plants that grow more rapidly.

We have already made some important advances in this direction. For example, scientists have been able to develop grain that can be harvested 30 days after it is planted. This means at least three crops a year. If we can push back the forces of hunger on one front, it should inspire our other troops to fight on.

For we still have a lot to do. What good are these wonderful new kinds of seeds if two thirds of the world's farmers are still using primitive plows? If they are still depending on animal power instead of mechanical energy to pull those plows?

Such conditions might have been acceptable 5,000, 1,000, or even 100 years ago, but not today, in our age of mechanical civilization. They all have to be brought up-to-date if we are to win the war.

The advanced countries of the world must give equipment, fertilizers, and know-how to the developing countries. Only in that way will the poorer countries be able to produce enough to feed themselves properly.

Above, left: In some parts of the world, a device known as Archimedes' screw is still used to irrigate land. Invented in the 3rd century B.C., *it consists of a long cylinder the inside of which is sectioned. Above: Indian oxen pull a bar that turns a waterwheel. Each container on the wheel spills its contents into an irrigation canal.*
Opposite page: The ox-drawn plow (above) used in present-day Egypt resembles the model (below), which dates from 2000 B.C.

Left: A typical irrigation canal in the Po Valley of central Italy. The water in the canal comes from springs.
Opposite page, top: This clay tablet shows what may be one of the oldest city maps in existence. It was found in the excavations of Nippur, a city of ancient Mesopotamia (now Iraq). The map shows the city's canals, whose source of water was the Euphrates River.
Opposite page, bottom: Swamps like this one are formed in areas where the water content of the soil is unusually high.

A THIRSTY WORLD

But the world is not only hungry, it is also thirsty for water. This may seem strange to you, since nearly 75 percent of the earth's surface is covered with water. But about 97 percent of this huge amount is seawater, or salt water. Man can only drink and use the other 3 percent—the fresh water that comes from rivers, lakes, underground, and other sources. And we cannot even use all of that, because some of it is in the form of icebergs and glaciers. Even worse, some of it has been polluted.

However, as things stand today, this small amount of fresh water, which is constantly being replaced by rainfall, is still enough for us. But our need for water is increasing rapidly—almost day by day. Only if we take steps to deal with this problem now can we avoid a severe worldwide water shortage later on. A limited water supply would have a bad effect on agriculture and industry. Let me give you just one small example of how necessary water is to industry. Did you know that to produce a single ton of steel, it takes about 20,000 gallons of water?

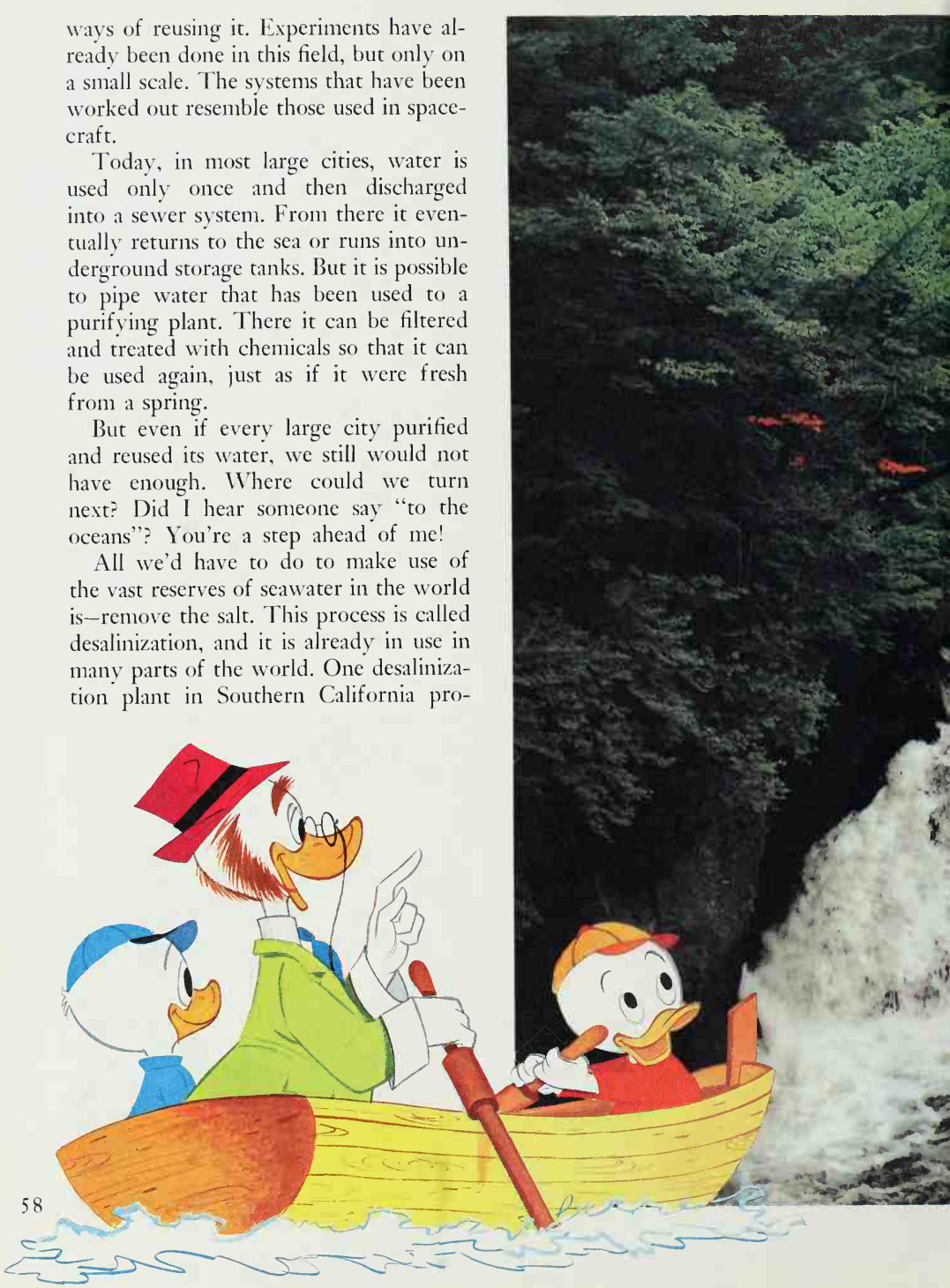
We all have to learn how to stop wasting our precious water. One of the first steps we should take is to develop

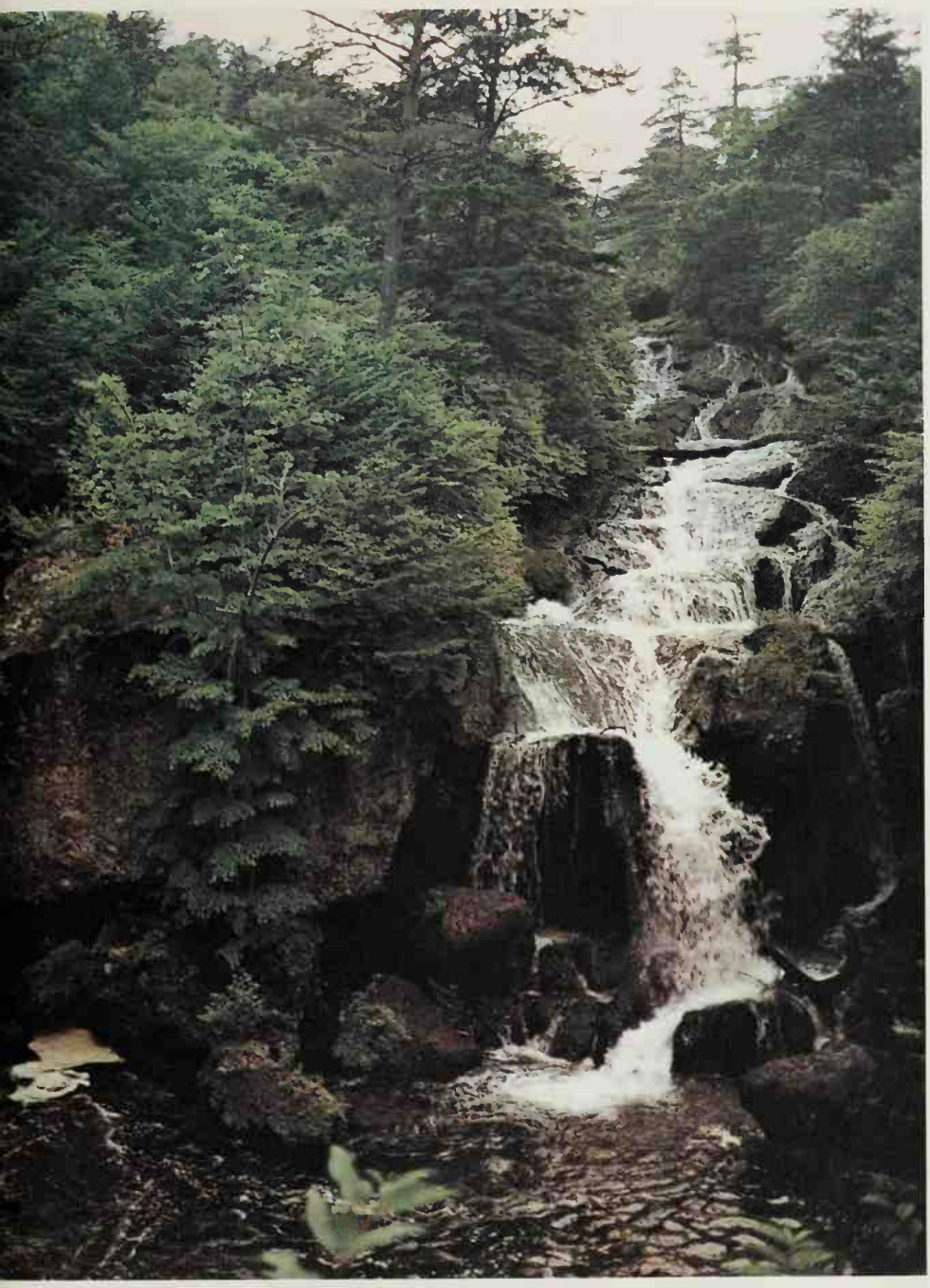
ways of reusing it. Experiments have already been done in this field, but only on a small scale. The systems that have been worked out resemble those used in spacecraft.

Today, in most large cities, water is used only once and then discharged into a sewer system. From there it eventually returns to the sea or runs into underground storage tanks. But it is possible to pipe water that has been used to a purifying plant. There it can be filtered and treated with chemicals so that it can be used again, just as if it were fresh from a spring.

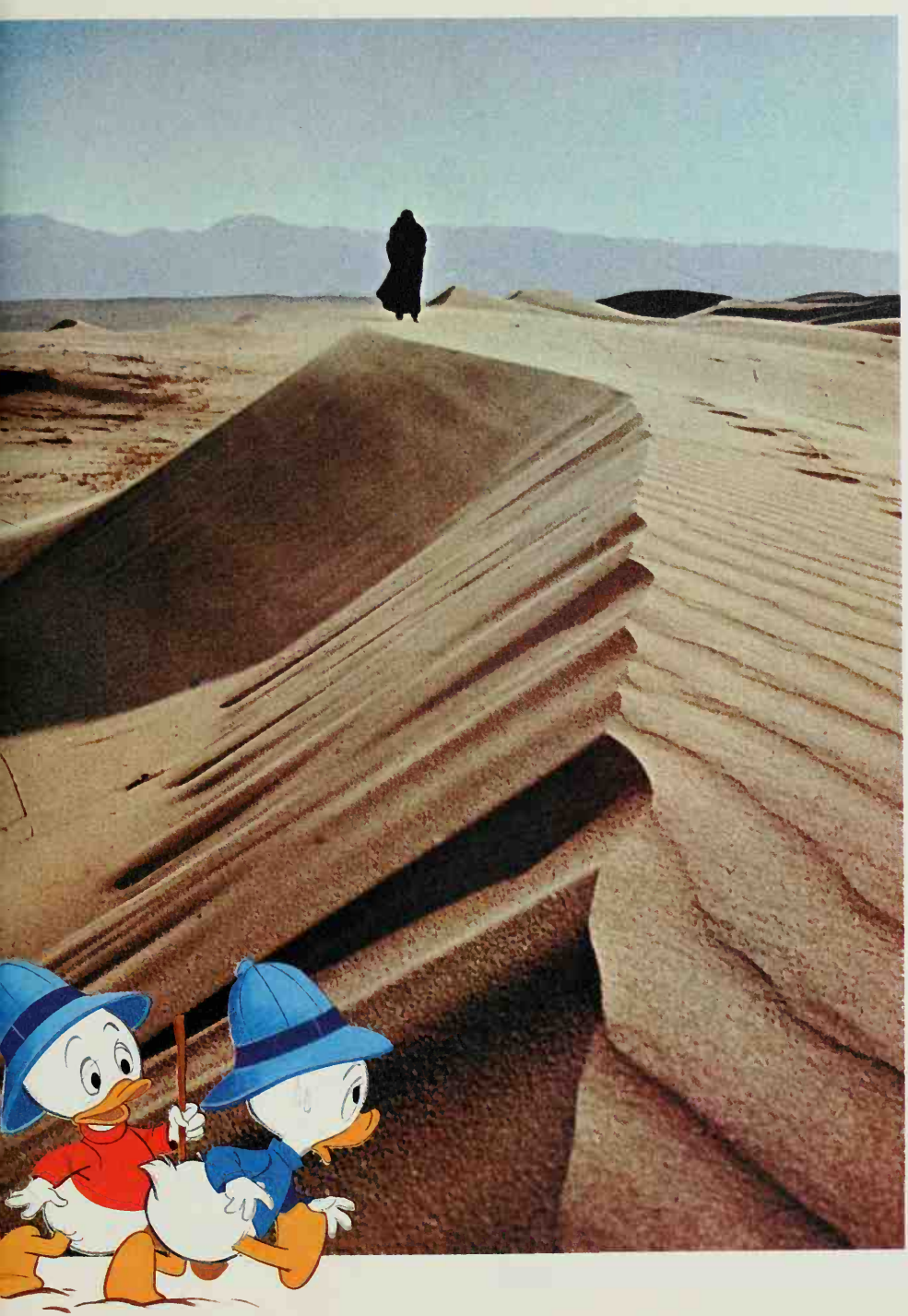
But even if every large city purified and reused its water, we still would not have enough. Where could we turn next? Did I hear someone say "to the oceans"? You're a step ahead of me!

All we'd have to do to make use of the vast reserves of seawater in the world is—remove the salt. This process is called desalinization, and it is already in use in many parts of the world. One desalinization plant in Southern California pro-





Above: The roots of the grasses and bushes growing from these sand dunes help to hold the dunes together and prevent the wind from blowing them away. Left: One of the few plants that now grows in desert areas is the date palm. Its sweet fruit is a valuable food for the people of these regions, and an alcoholic beverage is made from its leaves (right).
Opposite page: Part of the vast expanse of the Gobi Desert of Central Asia.



duces about 110,000 gallons per day.

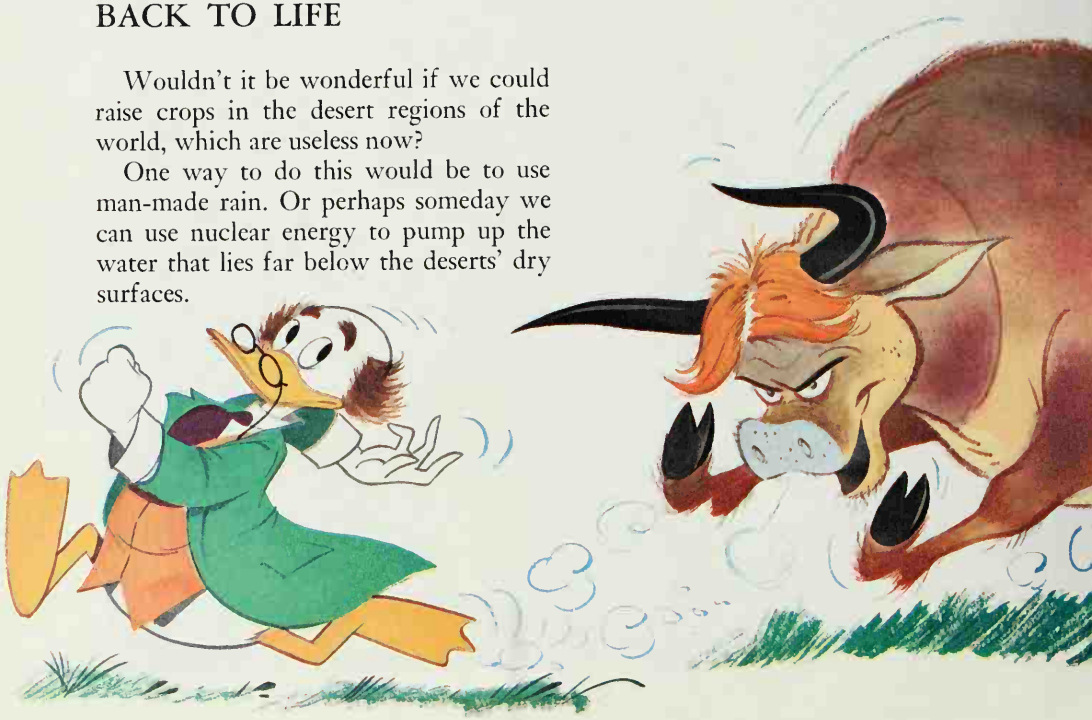
So you see, boys and girls, if we take these steps we'll be in no danger of drying up! But I'm afraid that'll be bad news for our friend Pluto. Bath water is his number-one enemy!

In many parts of the world, there are large areas of land that cannot be farmed.
Above: A Mongolian herdsman on horseback watches his camels. Camels are raised both for food and transportation. Little can grow in the desert and plateau areas of Mongolia.
Opposite page: Much of the Brazilian state of Mato Grosso consists of savanna, or dry grassland, suitable only for raising cattle.

BRINGING THE DESERTS BACK TO LIFE

Wouldn't it be wonderful if we could raise crops in the desert regions of the world, which are useless now?

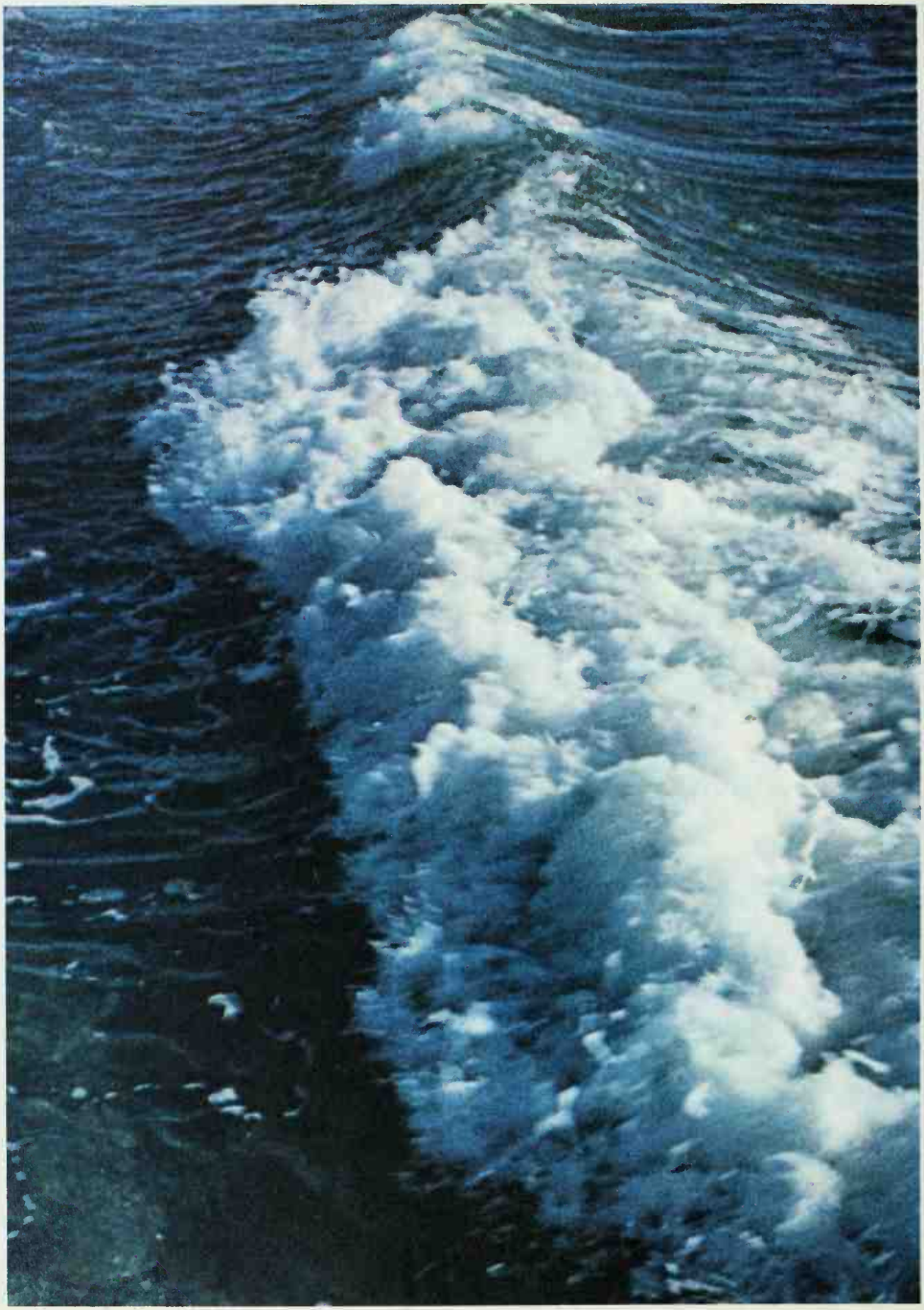
One way to do this would be to use man-made rain. Or perhaps someday we can use nuclear energy to pump up the water that lies far below the deserts' dry surfaces.



The science of meteorology (weather and climate) has made great progress since the invention of weather satellites. But we can also use our own observations to help us predict the weather. Above, left: A rosy dawn often means bad weather is coming.

Above: A cumulonimbus cloud, or thunderhead, brings rainstorms. (You can see the rain toward the lower left of the photograph.)

Above: Wispy, curved cirrus clouds are often called "mares' tails." They are seen high up in the atmosphere and often mean snow is on the way. Above, right: Altocumulus clouds usually occur in connection with high pressure, so they mean good weather is in store.
Below: Grab your umbrella and head for home —it's too late for forecasts now!



First we must prepare the soil so it will hold moisture. We'll start by sowing new kinds of plants that can grow in the desert. Slowly, step by step, the sandy deserts will change, and finally we will be able to grow important food crops there.

FARMING THE SEA

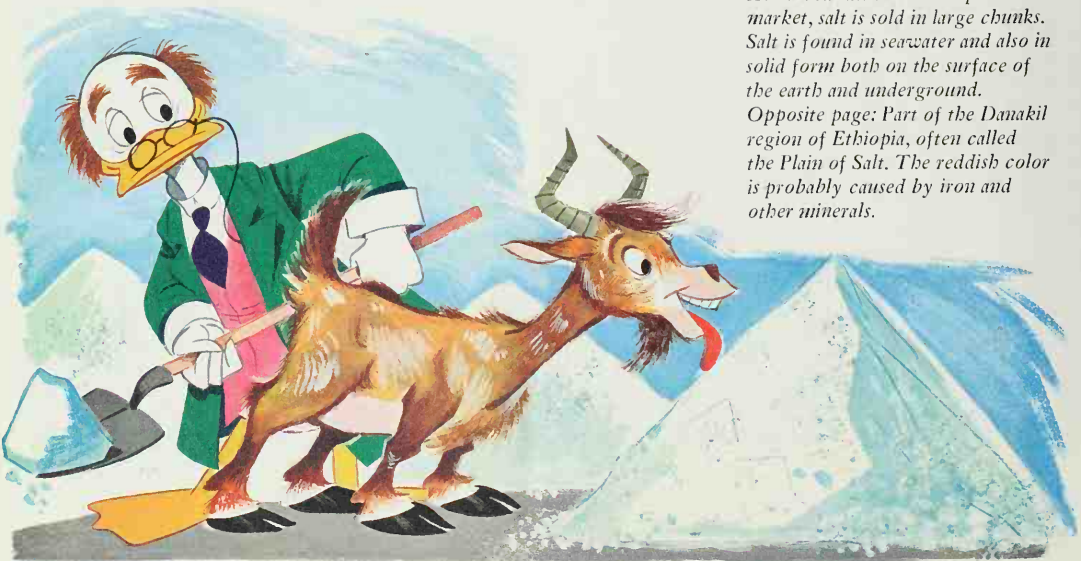
Up to now we've been talking about agriculture on land. It is the land that gives us most of the food we eat, whether it is animal or vegetable. Yes, of course, I said "animal." After all, those steaks and chops and that fried chicken and roast turkey we all enjoy so much came from the land, too. The grass of the pastures nourishes our cattle and sheep. Corn and other grains feed our poultry and hogs.

Every year, about 42,000,000 tons of meat are obtained from billions of acres of meadowland, pastureland, and farmland on the earth's surface. On the other hand, from an area that is much greater — the oceans — we only take about 33,000,000 tons of fish. These figures make it very clear that we are using only a tiny part of what the oceans have to offer.

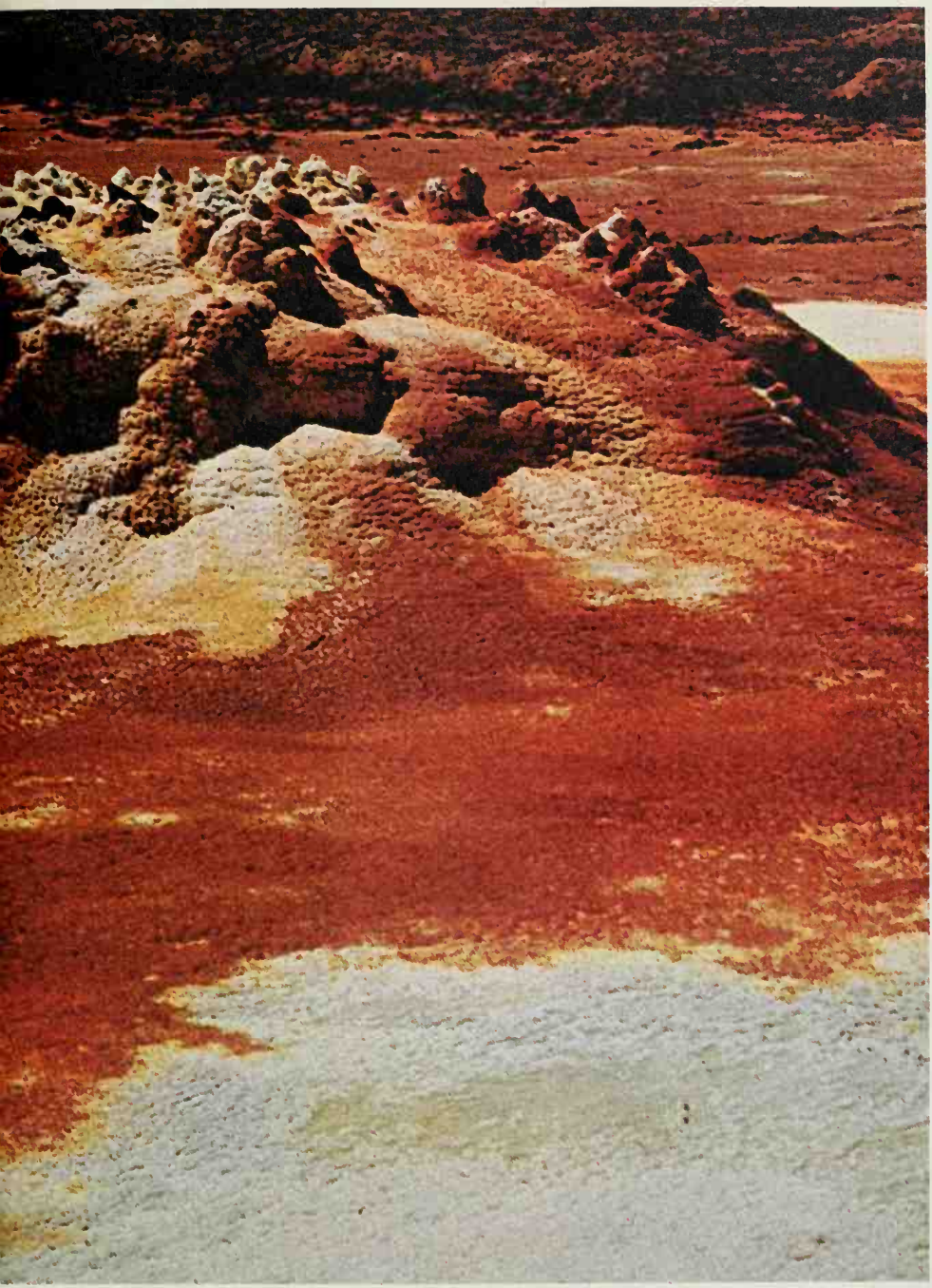
Part of the reason for this low yield is that fishing methods in many countries are still quite old-fashioned. Fishing has not been mechanized like so many other industries. Another reason may be that fishermen often do not like to venture too far from their home waters, though fishing may be much better far out at sea. But the real problem lies in how we think of the sea. Man does not yet consider the oceans as territory that can be cultivated, or farmed, as is done in fields and meadows.

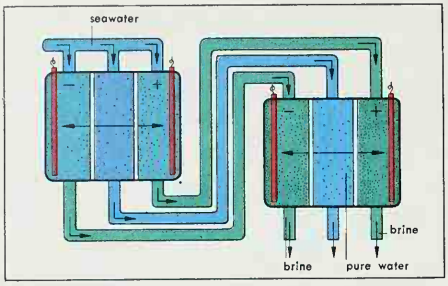
How can we begin to farm the sea? The answer is really quite simple. Fish abound wherever they find abundant food supplies. Their principal foods are those tiny forms of animal and vegetable life called plankton. By using low-cost nuclear energy, we could pump up the minerals from the sea bottom and bring them closer to the surface. This would create ideal growing conditions for plankton. In this way we would be forming real "pastures of the sea," which would attract fish to areas where there might have been too little food before. Oceanographers and marine biologists (scientists who study the seas and the animals and plants that live in them) also tell us that this system would greatly increase the number of fish.

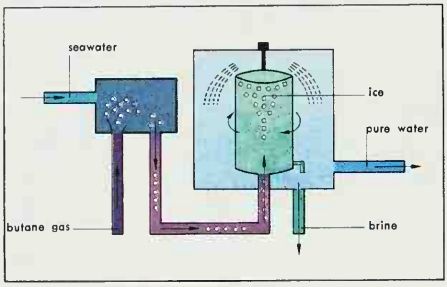
And just as we build fences on land, we could fence in the pastures of the sea by setting up electronic barriers around them. These will prevent the fish from escaping and protect them from attacks

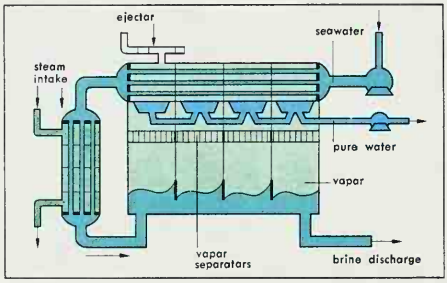


Above: In this Mexican open-air market, salt is sold in large chunks. Salt is found in seawater and also in solid form both on the surface of the earth and underground.
Opposite page: Part of the Danakil region of Ethiopia, often called the Plain of Salt. The reddish color is probably caused by iron and other minerals.

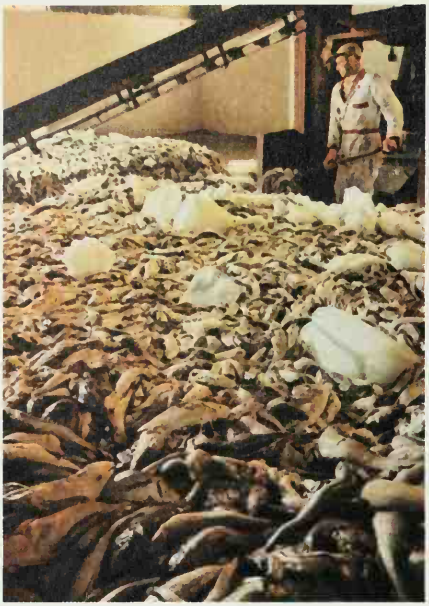


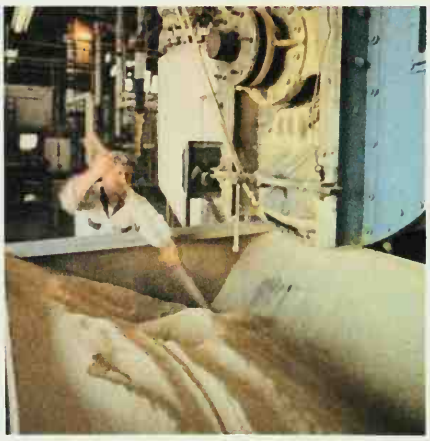






Because of our ever-increasing need for water, desalinized (desalted) seawater will play an important role in the future. Diagrams show three methods of desalinization.
Top: Electrodialysis (separation by electricity) is based on fact that the atoms that make up matter carry positive and negative electrical charges. Opposite charges attract each other. By using positively and negatively charged electrodes, salt is removed from the water.
Middle: In one type of thermal separation (separation by changing temperature) seawater is partially frozen by butane gas, then piped to a revolving separator. The ice floats and salt particles sink. When the ice melts, it is pure water.
Bottom: Distillation is another kind of thermal separation. It uses steam to heat and vaporize the water. The salt is drawn off, and when vapor cools, it condenses and pure water is obtained.
Right: In some areas salt can be gathered after the sun has partially evaporated the water.





Above: All fish have a very high protein content. Even so-called "low quality fish," or fish not considered suitable to eat, can be used. By means of special processes, they are ground up into a fine powder that resembles flour. This flour is already a valuable addition to the diet in parts of the world where people lack protein. It also makes an excellent food for livestock.

by bigger fish. A "fence" made of air bubbles would work, too, because most fish would not try to swim through it.

Finally, we could place cement "barns" on the ocean floor, in which to breed fish. These marine ranches would cover several hundred square miles. They could be inspected by men using small submarines or riding specially trained dolphins.

It all sounds a lot like the Old West, except there'll be no Indians down there, and we'll have dolphin boys instead of cowboys! But just as the cowboys took part in cattle drives, so these new "range riders" will move great herds of fish and mammals from place to place so they can always get the most food available.

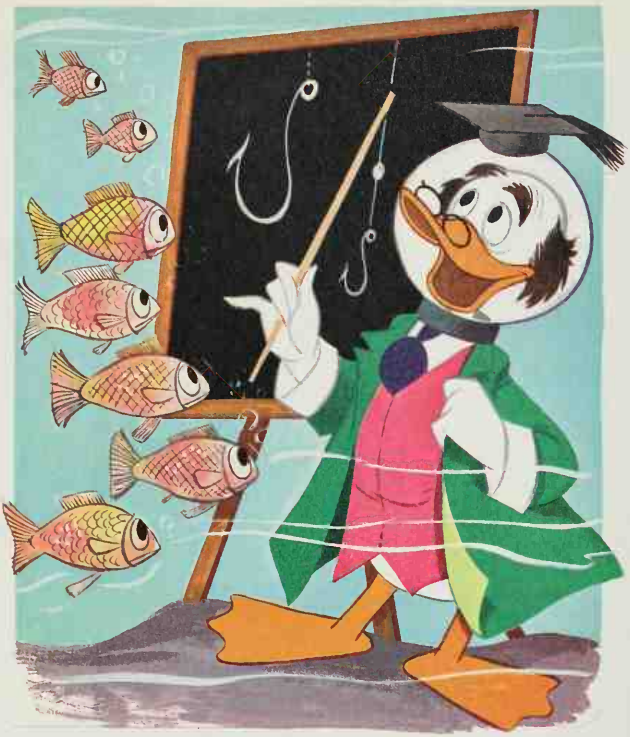
NEW SOURCES OF FOOD

F. P. C. and S. C. P., S. C. P. and F. P. C. . . . Now don't get scared, boys and girls—I'm not so absentminded that I've forgotten what we were talking about and started working on a secret code!

Those initials really stand for two foods that are going to be very important in the future. I'm sure you've already heard of protein. If there is no protein, or if there is too little of it, in the foods we eat, illness and even death can result.

We know that fish are extremely rich in protein. And yet many kinds of fish are of little interest to fishermen because they are not considered good enough to eat and so would not bring good prices.

But scientists have found a way to convert these "low quality" fish into a concentrated, powerful form of protein. They are ground up whole, bones and all, and then dried. The flourlike substance that results is almost 85 percent protein and is called Fish Protein Concentrate, or F. P. C. F. P. C. is already an important addition to protein-poor diets in some countries.



In the world of tomorrow, man will learn how to "farm" the bottom of the sea. He will turn the simple underwater plants called algae—such as seaweed—into valuable food. Chemists are already experimenting with Chlorella, a one-celled freshwater alga that reproduces very quickly and contains large amounts of important nutrients.

Scientists are also working on Single Cell Protein, or S. C. P., a tasteless, odorless vegetable protein that grows in crude oil. S. C. P. is a valuable food of the future, and it is one more man-made product whose source is petroleum.

THE MARVELS OF CHEMISTRY

Speaking of petroleum, let's take a look at the photograph on this page. What's that? You say you don't see what petroleum has to do with it? Well, look again! Except for those objects made of metal—and of course, the people themselves—almost everything in the photograph is made of synthetic, or man-made, materials. What's more, most of those materials were originally derived from petroleum, and they are among the many marvels of chemistry.

Substances called petrochemicals can be extracted from petroleum, or crude oil. These chemicals become the raw materials for dozens of synthetic products, such as plastics, fiber for cloth, and even "rubber." I'm sure that now you're beginning to see what I had in mind.

The largest object—the house—is a good example. Its walls were made by pouring liquid plastic into molds shaped like boards. When the plastic had set, the molds were removed. Special chemical compounds in the plastic made it strong, lightweight, highly weather-resistant, and long-lasting. And so the "house that chemistry built" was ready to be furnished—with synthetic products, naturally—and lived in.

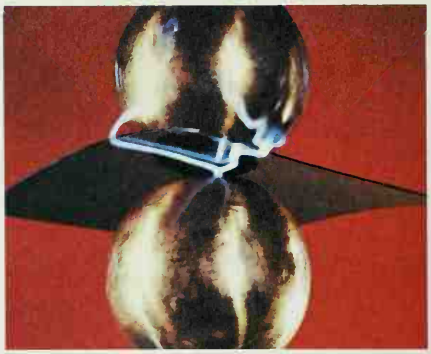
Most of the objects in this photograph are made of plastic materials. Plastics are among the most important—and most useful—contributions made by chemistry today. New types of plastics are being made nearly every day—almost as rapidly as new uses are being found for them.

CNGHO

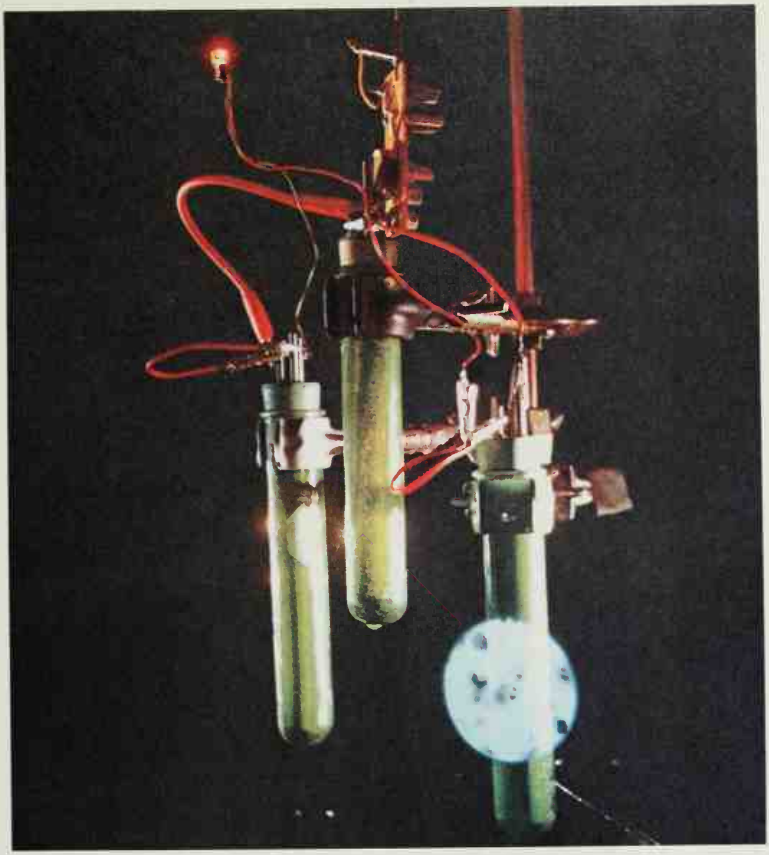
Since the invention of plastics early in the 20th century, these wonderful substances have become increasingly important parts of our lives.

Take polypropylene, for instance. This plastic, first made in 1957, was based on research by Giulio Natta, an Italian chemist, and Karl Ziegler of Germany. The two men won the 1963 Nobel prize in chemistry for their work. Polypropylene can withstand temperatures far above the boiling point of water. It is the lightest of all plastics. It is very strong, takes dyes well, and can be made into solid objects as well as fibers for textiles.

It's no surprise that polypropylene has become so widely used. Think of all the things that can be made from it—from brightly colorful household utensils to surgical instruments (which must be sterilized at high temperatures), from parts for computers and calculators to plumbing equipment, even carpets and curtains.



Top: A sheet of plastic is tested for its resistance to electricity.
Middle: Some plastics are used to make pipes.
Bottom: Skylights made of transparent plastic are more durable than those made of glass.
Opposite page: Rigid plastics are even being used for the outer shells and domes of sports stadiums.



In their search for more ways to help mankind, chemists have opened up new frontiers. Left: In some laboratories chemists work in such sterile conditions that they must be covered by special protective clothing. They can only communicate with those outside the lab by means of prearranged signals. Above: Note tiny light bulb glowing at the upper left of this photograph. The current that operates the bulb was produced by the rotted plant matter in the test tubes. These "bacteria batteries," mentioned in the text, are still being developed.

This is just a tiny part of what chemistry has to offer us as we move into the world of the future. Even today, research is being done to defeat the many diseases that still threaten man, and chemists are leading the fight. Maybe someday they'll discover the secret of long life!

The "magicians" of chemistry are even using mud from sewers and rotted plant matter to make "bacteria batteries" like the one on this page. These strange devices can actually produce tiny amounts of electric current. It really makes me wonder what the future has in store.

One thing chemistry will have to do is solve a problem it created. Remember all

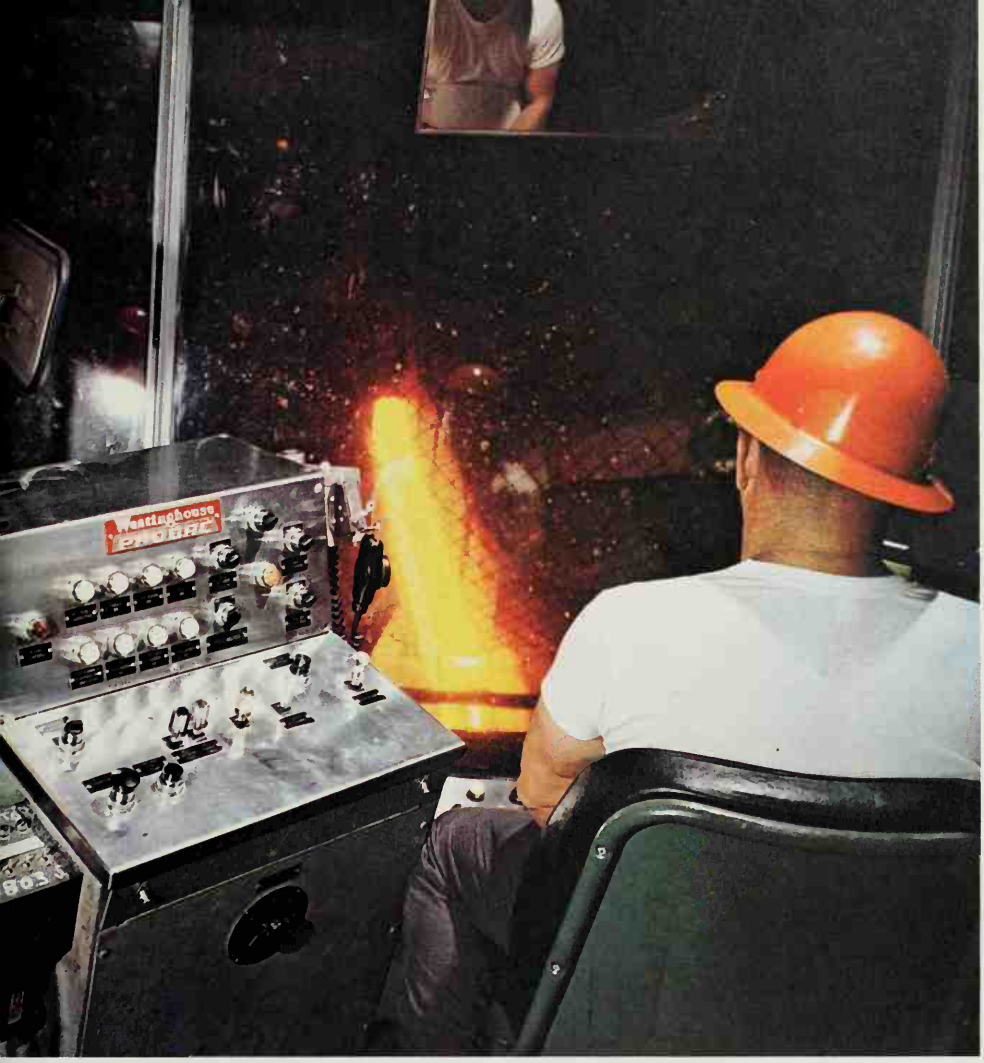
those plastics I told you about? Well, they're almost indestructible, and if chemistry doesn't find a solution soon, our earth may become one vast garbage dump!

MEN OR MACHINES?

The other day Uncle Scrooge and I were walking along a street when we we came to a fruit store. Some luscious red apples were on display. "For once in my lifetime I would like to buy some apples," grumbled the old super multimillionaire. "Maybe even two or three."

But when he saw that the apples were being sold at 10 cents each, he quickly turned away and hurried to his enormous house. We went inside and all the time he was muttering to himself about the high cost of apples. Then he took me into the huge robot room where George the electronic robot stood. Uncle Scrooge went over to George and pressed one

Automation progresses with each passing day. Extremely difficult and complex operations of the past are solved today by pressing a button. This is all due to the power of electronics. Above: An electronic machine that controls various stages of a steel casting. A technician sits at the machine and monitors the entire operation. Far from the heat, the smoke, and the danger, he is a new image in the iron and steel industry.



button and then another. Instantly the metallic voice of George was heard over the loudspeaker.

"Hum . . . hum . . . three times ten equals thirty."

"Well, well, well!" exclaimed Uncle Scrooge, rubbing his hands together contentedly. "This mathematical operation has cost me $82 just in the electrical energy that was consumed. But at least I now know that it will cost me 30 cents to buy those three apples. That shopkeeper will have no chance to swindle me by overcharging me."

"But, Uncle Scrooge," I protested, "this was such a simple example in arithmetic, you could very easily have done it all in your head."

"Your head can make a mistake. An electronic calculator cannot make mistakes," he said angrily.

Well, when it comes to the more diffi-

cult problems, I certainly cannot disagree with Uncle Scrooge. Especially when I know that in the world of tomorrow most of this type of figuring will be carried out by electronic equipment.

Will we then be slaves to these machines? I've heard this question asked many times. My answer is that machines are, and will always be, our slaves. Why? Because we will always be the makers, the inventors, the constructors, and the programmers. And we will be doing this because we want to be served quickly and accurately. Just remember it was Ludwig von Drake who told you this!

Now let me tell you something about memory and the electronic machines that have been invented by man. These machines do have a memory just as you and I have. Our brain stores up past ex-

periences that we call upon when we need them. The electronic machines are able to store information and then to call upon that information when it is needed. They operate with a speed that is slightly less than the speed of light. (Light travels at a rate of 186,282 miles a second.) These electronic machines are able to carry out a million operations of complex mathematics in one second! Many enterprises today have been made possible by these electronic calculators.

For one thing, without these electronic calculators we would never have been able to put a man on the moon. Thanks to these inventions the most difficult operations can be carried out in a few seconds. The laboratory on earth guides the spaceship on its celestial course. It can change the routes whenever errors in the original

Electronic computers for schools. These computers, at times, take over the function and place of the teacher. In this illustration a student is being questioned by a computer. The questions come to her through the earphones she is wearing. After looking at the picture on the screen, she types the answers on the machine.

plans begin to show up.

So, boys and girls, we look forward to seeing more and more advances in the world of technology—advances that will certainly help to make our lives better and richer. But we are already enjoying some of the benefits of electronic progress. In schoolrooms teaching is enriched by the use of films and television. Libraries have books and newspapers that are recorded on microfilm. We can sit at a table, project the film onto a screen, and read a book or a newspaper. We also have spools of recording tape as small as the palm of your hand. One tape can contain as much information as will fill many pages of an average book. Imagine carrying the text of a thick book in a few ounces of tape! Wouldn't that tape be a nice change from the heavy school bag you sometimes have to carry?

These are just a few of the present-day miracles. Tomorrow's will be even more astonishing. We are already producing instruments made of parts so tiny they can be seen only under a high powered microscope!

ELECTRONIC TEACHERS

Electronics have come into the schoolroom to help the teacher and the student with their work. There are devices already in the schools that actually take over some parts of the teacher's job.

Let me tell you, boys and girls, about

question that is received on the teletype machine. The student studies the question and responds by typing the answer. The computer center then selects the next question, based on whether the student's answer is right or wrong. The center may decide that the student needs further work, or it may decide that he is ready for the next idea. At present Computer Assisted Instruction is a costly operation. But with the passing of time and further study on the part of engineers and scientists, it is certain that the cost will be greatly reduced. And with so many countries faced with a shortage of competent teachers, CAI, or a system similar to it, should be able to relieve this situation somewhat.

New technical discoveries are of increasing usefulness to teachers and pupils.
Above: A film is being shown to the students on closed circuit television. It is a documentary film on small animals. The teacher coordinates the film with her classroom instruction.
Right: Simple arithmetic is taught to a young child with the help of a teaching machine.

Computer Assisted Instruction, or CAI. The student sits at a teletype machine that is something like a typewriter. The computer center that controls the teletype machine may be many miles away from the school. The center sends out a

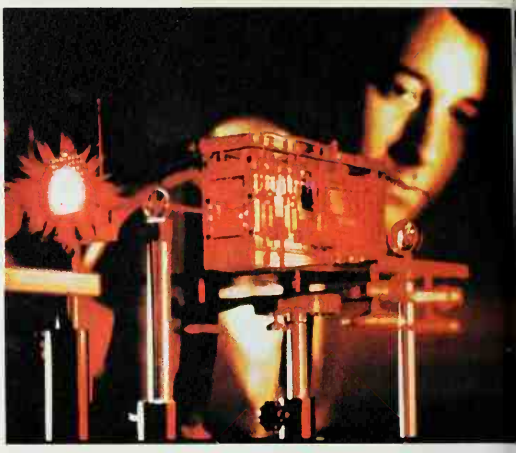
THE LIGHT OF THE FUTURE

Now let us forget the school of tomorrow and discuss some other inventions that have great bearing on our lives today

and in the future. We're going to talk about masers and lasers. Masers and lasers are important new devices being used in science and industry. The words "maser" and "laser" are formed from the first letters of some long scientific words. The "m" and "a" in maser stand for "microwave amplification." The first two letters in laser stand for "light amplification." The "s," "e," and "r" stand for "stimulated emission of radiation."

Maser and lasers are important because with them scientists can handle radio and light waves in ways that were impossible before. The first maser was developed in 1954. The first laser was designed 6 years later, in 1960. The laser is a further development of ideas that went into building the maser.

The value of masers lies in their ability to amplify microwaves. A maser can change a weak beam of microwaves and make it into a strong beam. Microwaves are like the very short radio waves that



The laser is a discovery whose importance will be felt in the world of tomorrow. The first laser was designed in 1960 by the American scientist Theodore H. Maiman. Above: A technician studies a laser beam.
Opposite page: A laser can transform a weak beam of light into a strong beam. Some lasers produce beams so strong that when they are focused they can burn tiny holes in strips of steel in less than a second. Here a scientist uses a gun-shaped laser to pulverize an electric bulb.

bring the picture from a television station to the screen in your home.

A maser can help astronomers pick up faint radio waves coming from outer space. Some masers are used in scientific laboratories as timing devices. These masers produce a steady radio signal. The signal provides a way of measuring time that is more accurate than the timekeeping of mechanical clocks.

The first letters of "laser," you remember, tell you that a laser amplifies light. The laser can take a weak beam of light and make it into a strong beam. This light is different from ordinary light. Some lasers produce beams so strong that when they are focused, they can burn tiny holes in strips of steel in less than a second. And laser beams can travel long distances through space without spreading out and growing weaker. Because of this they may become an important means of communication in the space age. Many uses have already been found for lasers in medicine, science, and industry.

So you can see, boys and girls, how important lasers and masers will be in the world of tomorrow. I can already see you in your spaceships talking to each other through laser signals!

DREAMS BECOME A REALITY

The father of modern science fiction was Jules Verne. Written in the past century, Verne's novels inspired whole generations of scientists. It has been said that Verne traveled more widely in his imagination than any writer who ever lived. He wrote of flying machines, of ships that traveled thousands of leagues under the seas, and of cannons that fired projectiles to the moon. Many people reading Verne's books 100 years ago shook their heads in disbelief.

"That madman," they said, "has plenty of imagination. Where in the world does he get those fascinating ideas? But they are utterly absurd and can never, never be put into practice!"

We all know that these wild ideas have become realities. We have flying machines and submarines, and we have made flights to the moon. So we have seen impossible dreams come to pass.

But a careful study of history would show us that every century has seen the impossible happen. Now go back in time, to the days of the Romans.

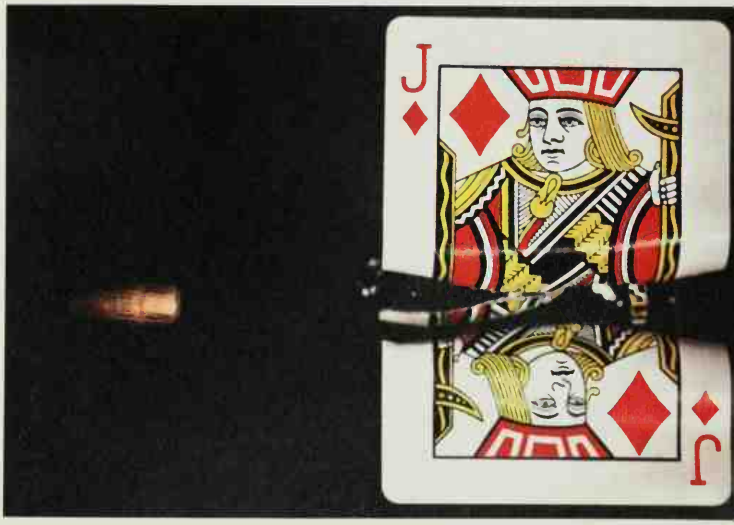
Can you imagine what a Roman would have said if you had told him that in the

future his racing chariot would be propelled by a motor? "Without horses?" he would ask in astonishment. You would nod and he would immediately think that you had lost your mind. And if someone told the people during medieval times that in the future their homes would be illuminated by a mysterious light enclosed in a small glass globe? Well, well. They would think that you were talking about black magic.

Now let's take ourselves to the beginning of this century. Someone says that within a generation or two people will sit in their living rooms and see things that are actually taking place thousands of miles away from them. "Nonsense!" the listener exclaims.

Yet today we do sit in our homes and see astronauts landing on the moon. It was not madness, not magic, not an idle dream, but the work of dedicated scientists that has given present-day life so many comforts, luxuries, and conveniences.

Let's consider television again. As you know, a television camera, or telecamera,



We hear of rocket planes being used in the world of the future. One plan is to have these planes transport freight over long distances.
Opposite page: This drawing shows the trajectory of an imaginary rocket plane, which is launched from San Francisco and headed for Singapore. It is estimated that this crossing could be made in 39 minutes, including time lost in departure and in landing.
Right: The future has already begun in high speed photography. The playing card in illustration was cut in two by a bullet fired from a pistol, but photograph was taken so quickly that the card did not have time to separate. Exposure time needed to make this photograph was 3 millionths of a second.
Above: A drop of milk photographed the instant it hit a polished surface.

picks up an image and through electronic means "sends" it to its destination. Here the image is reproduced on the television screen. This is a commonplace event which no longer surprises anyone. But what about the possibility of using television as a means of transport or, to put it better, as a means of teletransport? You're amazed, aren't you?

Well, according to some thinkers, in the same way in which an image of a person is transmitted from one point of space to another, so it will be possible to send a real flesh and blood person from one place to another. Just have him stand in front of a special telecamera and—zoom! —a radiation of energy will transport him immediately from New York to Paris or from Cape Kennedy to the seas of the moon. All this without use of spaceships!

Few scientists consider this to be possible. They call it science fiction.

But, on the other hand, let's remember that at the beginning of this century few people believed it would be possible to send a man to the moon, or to develop atomic energy, or to break the sound barrier!

FASTER THAN SOUND

Breaking the sound barrier was a great achievement. Sound travels at a speed of 760 miles an hour at sea level. Its speed is less at higher altitudes. On October 14, 1947, a major of the United States Air Force flew a specially designed plane, the X–1, faster than the speed of sound. He proved that a well-designed plane can break the sound barrier.

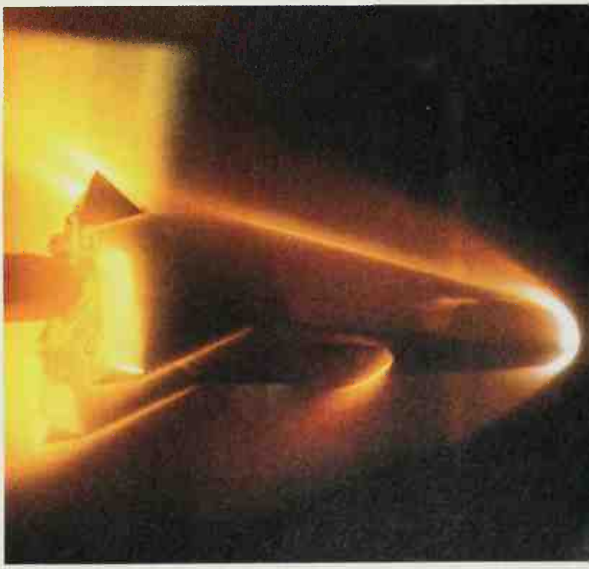
Flying at a speed greater than the speed of sound is called supersonic flight. The word "supersonic" comes from the Latin words meaning "above" and "sound." Flying at a speed less than the speed of sound is called subsonic flight. "Subsonic" comes from the Latin words meaning "under" and "sound." In 1909 the top speed of an airplane was about 50 miles an hour. Today in the short period of only

Above: A model of a vehicle for the exploration of space. This model is under study in a special wind tunnel built by NASA. Space scientists are working constantly to improve the design of space vehicles.
Below: The same model as above is exposed to a "wind" capable of generating more than 5,000 degrees of heat.

60 years, planes fly at speeds of over 1,600 miles an hour.

We are coming into an age when it may be possible to board a huge jet-propelled plane that will cover thousands of miles in less than an hour. Planes of this type are now being planned and worked on and it is expected that they will be in the air some time in 1980.

Just think of the exciting adventures that lie ahead! You will be able to go around the world in a few hours. You will be meeting peoples of different countries and different cultures. You will exchange ideas and learn of each other's hopes and problems. Perhaps with increased knowledge and understanding of each other the peoples of the world may yet learn to live together in peace.



THE WORLD OF TOMORROW

Before we continue our journey toward a future that holds so much promise, let us pause for a moment and take a quick look around us.

What a mess!

People who live in large cities or near industrial plants are only too familiar with one of the worst problems facing us today—air pollution. To pollute means to make unclean, and that is just what is happening to our air. It is becoming dirty!

Some of the blame rests with the exhaust from automobiles and the smoke produced by factories. Since we cannot get rid of automobiles or factories, we must get rid of their drawbacks. We have been trying to do this generally in two ways: by installing devices that will reduce pollution-causing gases, and by using fuels that will produce less pollution to begin with.

Now take a look at the illustrations on the next two pages. This is what the engineers and scientists have planned for us for the world of tomorrow.

As you can see, entire areas of our cities would be covered with enormous transparent plastic domes. Living under these air-conditioned covers means that we will cease to be slaves to the seasons. No longer will we shiver from the winter cold, or sweat because of the summer heat. And, perhaps best of all, we will not have to breathe polluted air.

But what about the people who will be living in these cities of the future? Will they be prisoners under the protective domes? No! They will have to move about—to travel to work and to school and to take vacation trips.

TIME IS MONEY

If we are to profit from these advances, however, we must adopt the motto of my friend Uncle Scrooge: Time is money.

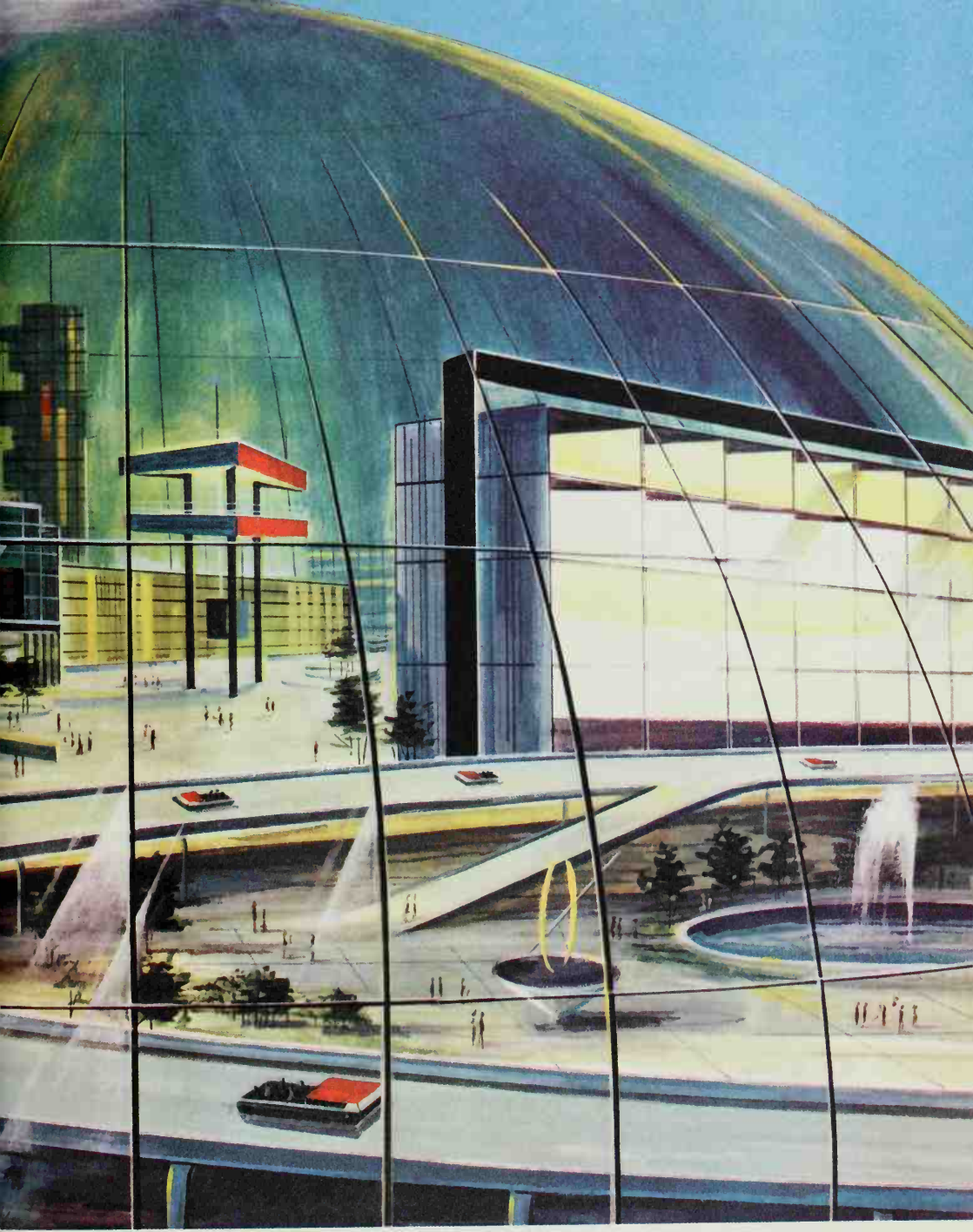
Well, let us see how we are wasting our time and making ourselves uncomfortable to boot.

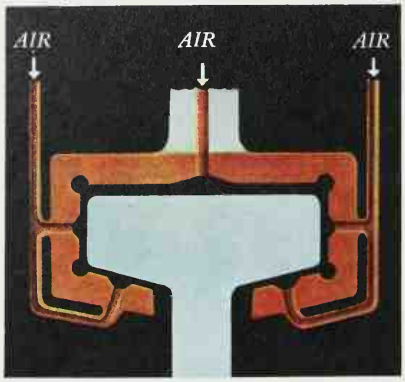
Workers who live faraway from their jobs lose hours every morning and evening traveling between their homes and jobs. How many things could we do with the time we waste on long train, subway, or bus rides? Or while we wearily drive a car through slow-moving traffic?

And what of the businessman? What does he gain by taking a speedy 1-hour airplane flight between cities, if he loses

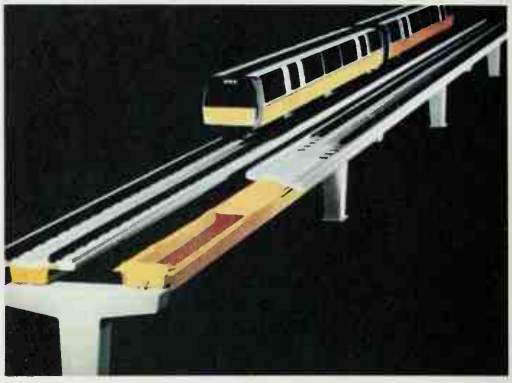
ETERNAL SPRINGTIME FOR THE CITIES OF THE FUTURE

This is the dream of General Electric engineers in California, who are working on plans to enclose an entire city under air-conditioned, clear plastic domes. The inhabitants would enjoy clean air and a constant temperature all year long.





If the speed, comfort, and safety of our trains are to be improved, the combination of wheels and tracks we know today will have to be eliminated. One way of accomplishing this would be to use "cushions" of air to support the trains. See diagram above.



How to connect suburban areas with the city centers is one of the problems affecting mass transportation. A solution to this problem might be through the use of elevated railways. A model of such a railway, designed by United States Steel, is shown above.

another hour just traveling between airport and town?

It is clear that to prepare for the world of tomorrow we must first improve our methods of transportation.

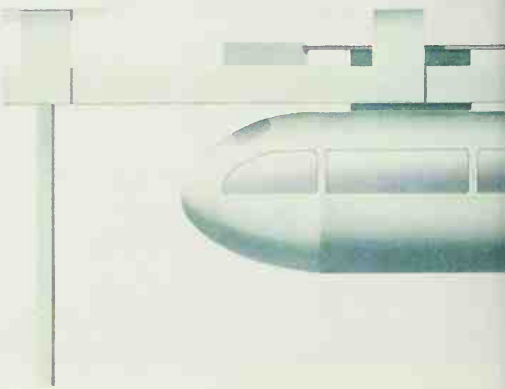
NEW IDEAS IN MASS TRANSPORTATION

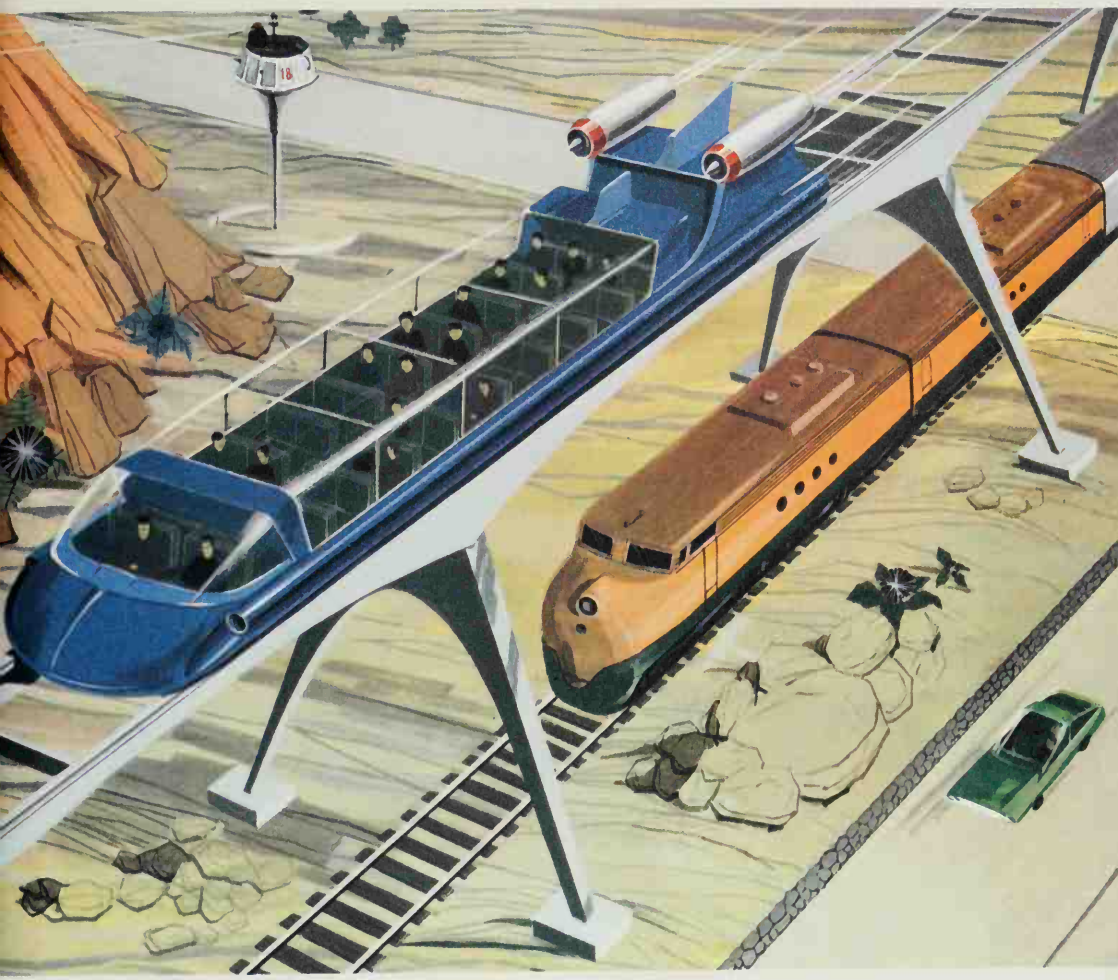
When many people must travel at the same time, trains are the most practical form of transportation because they can carry large numbers of passengers. Several countries already have in operation monorail trains that can travel at speeds of well over 100 miles an hour. Monorail means single rail. The illustration on the bottom of this page shows a monorail train.

Even more advanced trains are being built. One kind rides on a cushion of air and is based on the principle of a vehicle called the hovercraft. Air-cushion trains do not touch the rails but hover a few inches above them. They are expected to achieve speeds of several hundred miles an hour. This is possible since the air-cushion reduces friction.

Another kind of experimental train would use two magnetic fields. I'm sure you know that magnets have two poles —a north and a south pole. The opposite poles (north and south) attract each other. However, the same poles (north and north or south and south) repel, or push each other away.

Well, on this train both the railroad tracks and the train itself would be magnetized. But both would have the *same* polarity. Thus, as the train sped along





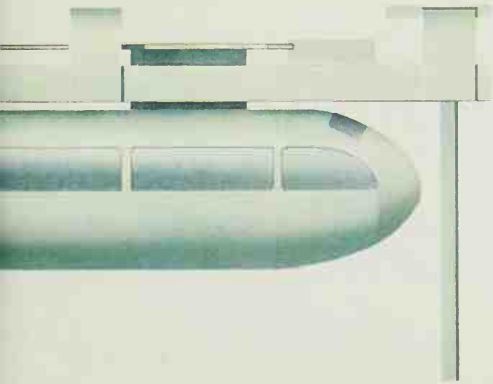


Illustration above shows what traffic of the future may look like. At the top of the picture, an elevated, air-cushion passenger train glides along powered by an engine that gives it a speed of over 500 miles an hour. Underneath the elevated train runs a train similar to those in operation now. These will be used to carry freight and will stop at every station. Note the excellent use of space: since the air-cushion passenger train is elevated, it allows the space underneath to be utilized by the freight train. The green car at right is a turbine-propelled vehicle.
At left: A monorail train. It runs suspended from the single track above it.

it would remain suspended above the tracks by the repelling action of the two magnetic fields.

This magnetic train could be propelled by one of several kinds of engines, which are now under consideration.

Plans are also being made to develop a jet train. It would run through an enormous tube from which the air had been removed. Removal of the air would reduce resistance, allowing the train to travel at the fantastic speed of almost 2,000 miles an hour.

These and other designs still on the drawing boards indicate a promising future for the train as a form of practical mass transportation.

In thinking about trains, however, we should not forget our old friend the automobile. Engineers and designs have many surprises in store for us for the automobiles of tomorrow.

GOOD-BYE WHEELS?

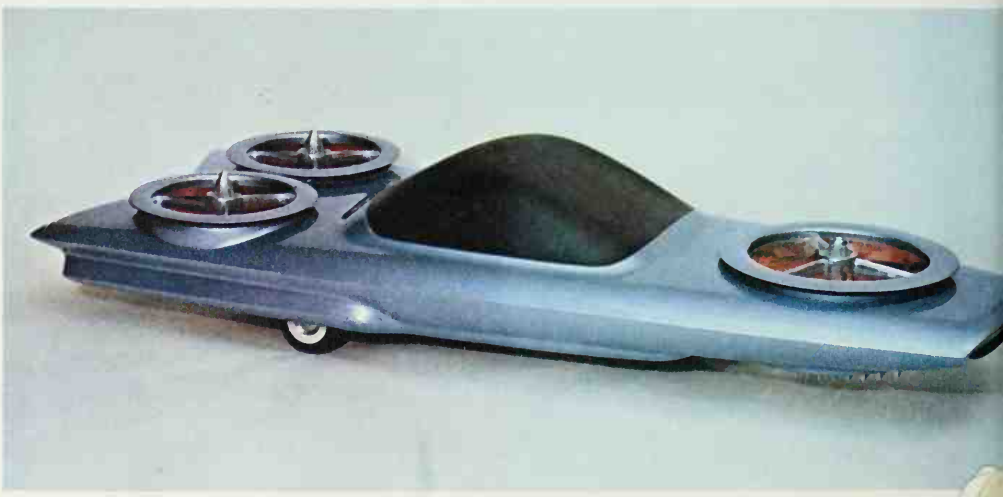
I am sorry for my faithful old tub of a car, but the automobile of today must eventually disappear. It will be replaced by new types of vehicles, which will be safer, more comfortable, and "cleaner" than our present 4-wheeled air-polluters.

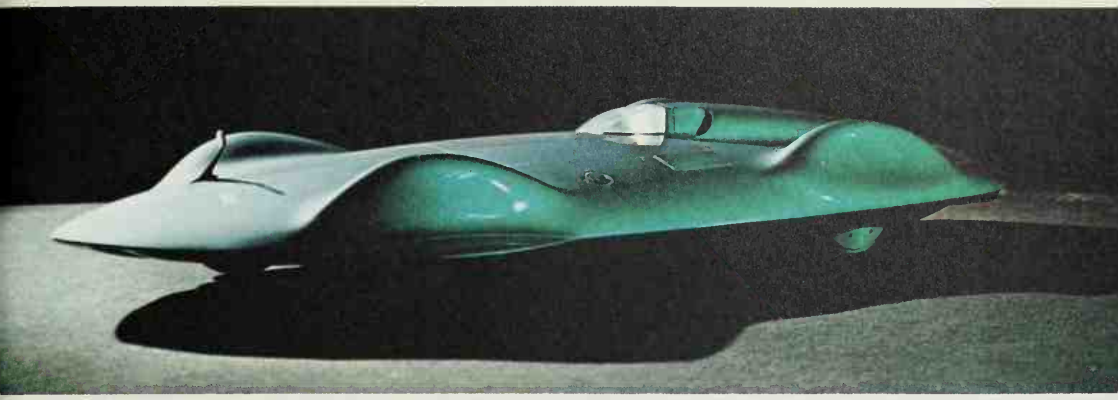
What will the car of the future be like? Well, I cannot tell you definitely. I do not know if they will be powered by electric engines, gasoline engines, or some other kind of engine. In fact, I'm not sure if they will even have wheels!

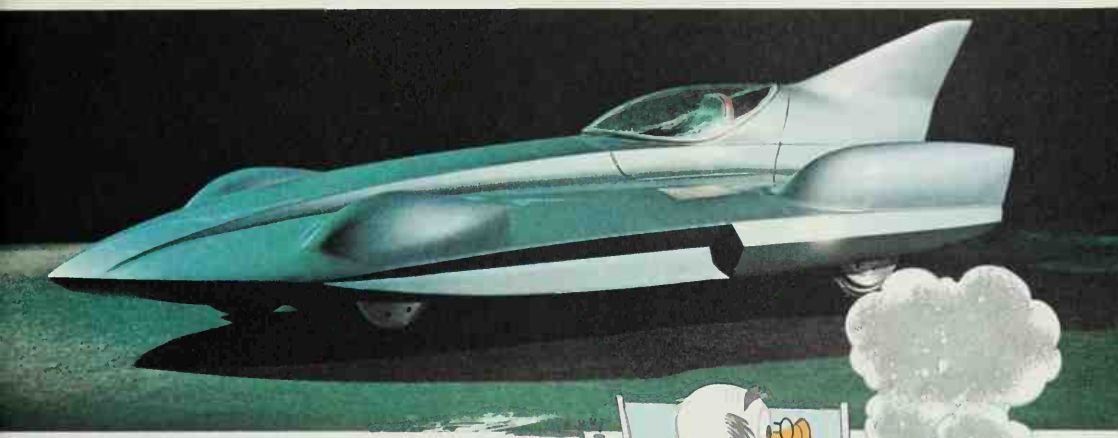
Wheels naturally would be useless if air-cushion automobiles come into general use. Yes, that's right. Cars as well as trains of the future may travel on a cushion of air.

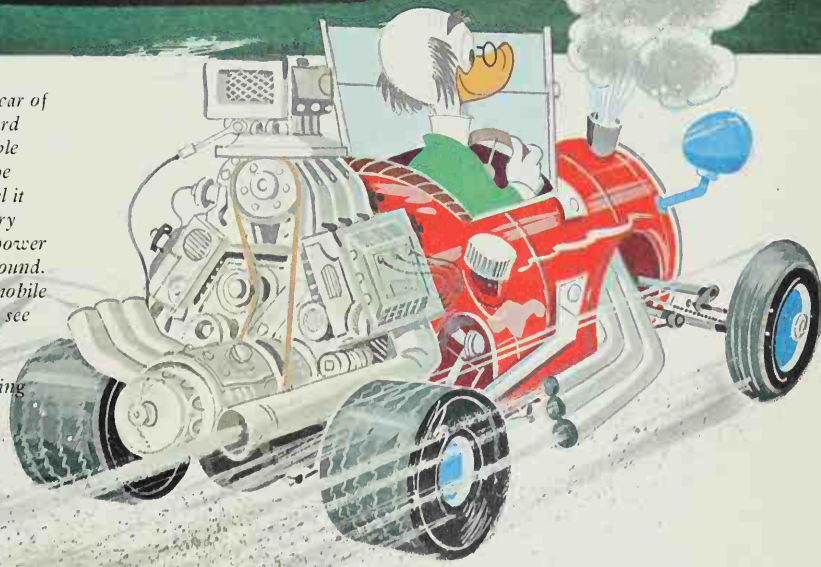
Some of these experimental automobiles are already in limited use or are being tested to see if they will work. They bear rather serious-sounding names, such as GEM (Ground Effect Machine) and ACV (Air-Cushion Vehicle). But they are all variations of the hovercraft I mentioned earlier.

Perhaps, at this point, I should stop for a moment to give credit where it is due. The hovercraft, one of the most promising vehicles of the future, was developed in the 1950's. One of the pioneers in its development was the English engineer C. S. Cockerell.









Opposite page: A model of a car of the future designed by the Ford Motor Company. It will be able to "fly" as well as travel on the surface. Three turbines propel it while in the air and an ordinary gasoline engine will provide power to the wheels while on the ground. Top: A model of a Fiat automobile of tomorrow. The driver will see the road through a periscope mounted forward. Above: A model of a Fiat racing car.

Cars of the future might very well be propelled by turbine engines. Turbines operate on a different principle than the piston-driven gasoline engines used in automobiles today. They have certain advantages over piston engines. Turbines are simpler in design, have fewer parts, and are therefore lighter and easier to maintain. Since they do not produce vibrations, they offer a smoother ride. Turbine engines also can be operated on a less expensive kind of fuel, such as kerosene.

The turbine engine has certain disadvantages, however. The metal alloys used in its construction are expensive, and the turbine itself, in certain ways, is a less efficient engine than our familiar gasoline engine.

But since many cars of the future will emphasize comfort and safety, rather than quick "pick up," this disadvantage may not be too serious.

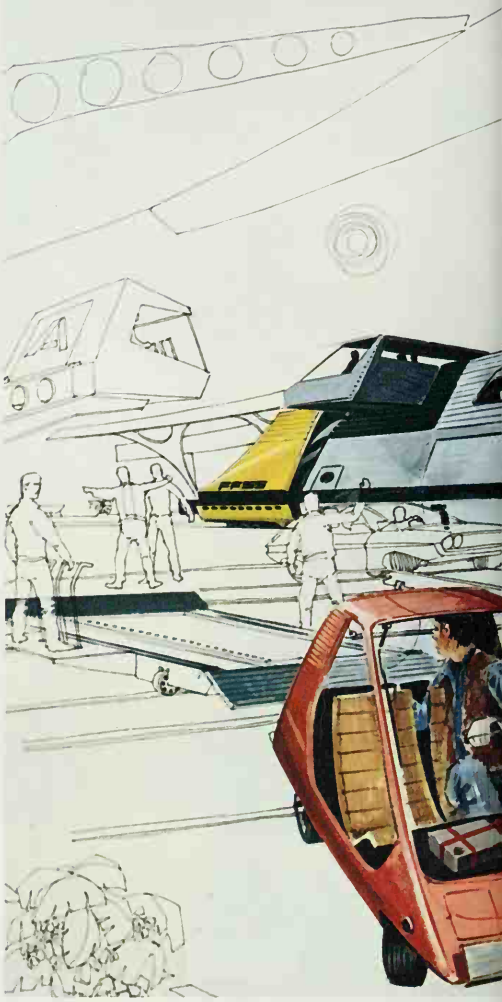
At present turbine engines are being used in several kinds of large, very powerful vehicles. One is a giant 30-ton tractor.

THE ELECTRIC CAR

Grandma Duck has been using an electric car for years—more years than she will admit—and she is very satisfied with it. Many people liked the old electric car, which goes back to the early days of the development of the automobile, for it had many desirable features.

Electric cars run smoothly and quietly and there are no smelly fumes as in gasoline-fueled automobiles. Electrics are easy to operate and require fewer parts. They need no starter motor, radiator, carburetor, gears, or clutches—not even a muffler.

Electric cars did have two great disadvantages, however, which led to their decline. These were low speed and a bat-



In the very near future, railways and automobiles will have to co-operate closely to solve the problem of rapid travel over medium and long distances. The Fiat company of Italy proposes the solution shown in the illustration above: Automobiles will be stored in the sides of the trains through the use of a simple undercarriage. The automobile pictured in the foreground is powered by an electric motor with a special battery and is designed for city travel.

tery that had to be recharged after the car had traveled only a fairly short distance. The batteries were also very large and occupied much of the automobile's available space.

But experiments with modern electric cars have led to new designs that may yet rescue the old electric car from its retirement of many years.

(Grandma would say that it should never have been retired in the first place.)

The new models will be able to travel much faster than the old electrics, although speed is not too great a problem. The cars are intended to be used by people who do not require high-speed automobiles—shoppers, people running short errands, or parents taking their children to school, for example.

Probably the greatest obstacle that re-

Two automobiles used in science-fiction and adventure films. Some of their characteristics may turn up in cars of the future.
Top: This "Turbo-Sonic" car weighs only 200 pounds.
Above. The "Batmobile" is equipped like a traveling police station. It is also armor-plated and covered with 40 coats of a special paint.

mains to be overcome before the electric car will reappear on the roads is that of the battery.

Experiments are being carried out on batteries that will be smaller and cheaper, as well as many times more powerful than the kinds used in the old electric cars. They should provide a longer road life between rechargings for the electric automobile of the future.

Tests are also being made on the use of fuel cells as a method of powering automobiles. Fuel cells transform the energy produced by the chemical reaction of certain fuels, such as kerosene, alcohol, and natural gas, into electric energy.

FLYING VEHICLES

High speed automobiles, comfortable automobiles, safe automobiles, economical automobiles, and automobiles that will not pollute the air.

The car of the future will have many, perhaps all, of these desirable qualities.

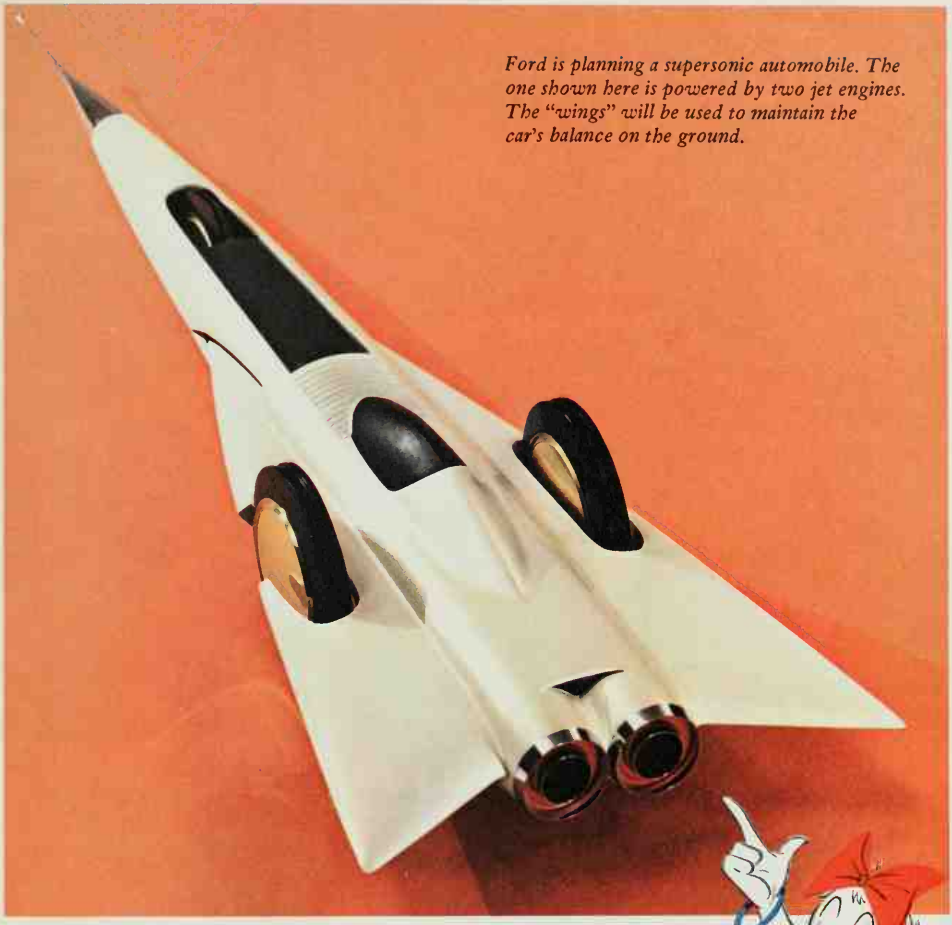
Will the future car also fly? That seems like a lot to ask.

Remember the hovercraft, or the Air-Cushion Vehicle, as the engineers prefer to call it?

When the first hovercraft experiments were being carried out, the cushion of air lifted the vehicle less than 20 inches off the ground. This was dangerous. It wouldn't do to have your car always bumping into every little thing!

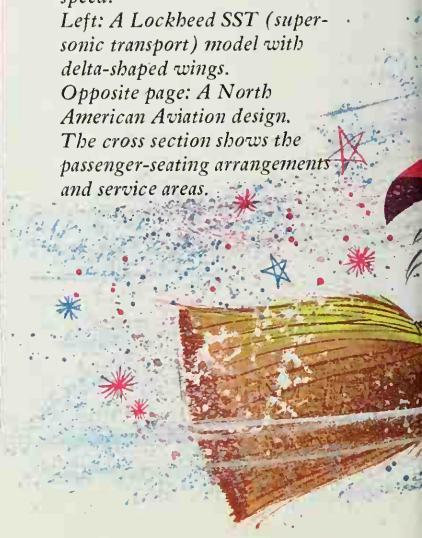
Today the new types of Air-Cushion Vehicles hover at least a yard above the ground. They are also bigger and more powerful. The main advantage of this kind of vehicle, as you can imagine, lies in the fact that it can go anyplace, on the road or off the road. It requires no specially paved highways, as cars do today. In fact, having no wheels, it has no need for roads at all!

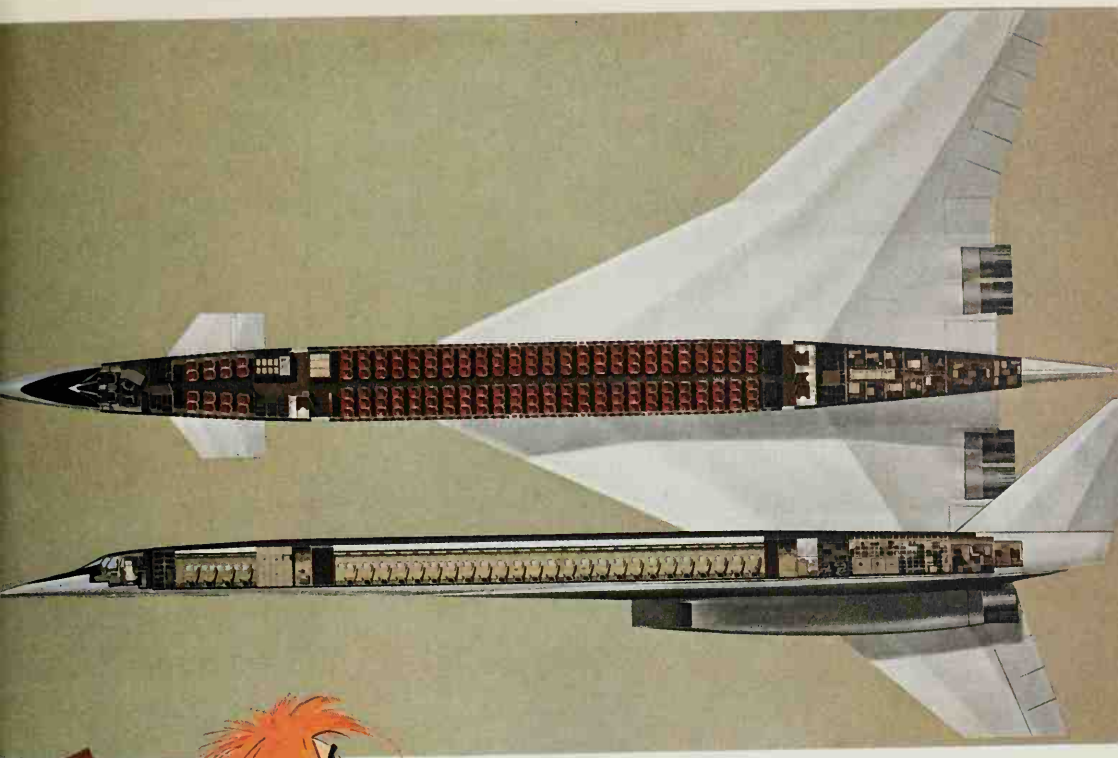
Just think, miles and miles of concrete and asphalt could be turned into grass lawns or given over to cultivation. How nice it would be to fly knee-high over a bed of tulips or a long row of vines filled with grapes—and to be able to help oneself in passing!



Ford is planning a supersonic automobile. The one shown here is powered by two jet engines. The "wings" will be used to maintain the car's balance on the ground.

Some models of airplanes we may see in the near future.
Above: This Boeing supersonic design has wings that can be adjusted according to the plane's speed.
Left: A Lockheed SST (supersonic transport) model with delta-shaped wings.
Opposite page: A North American Aviation design. The cross section shows the passenger-seating arrangements and service areas.



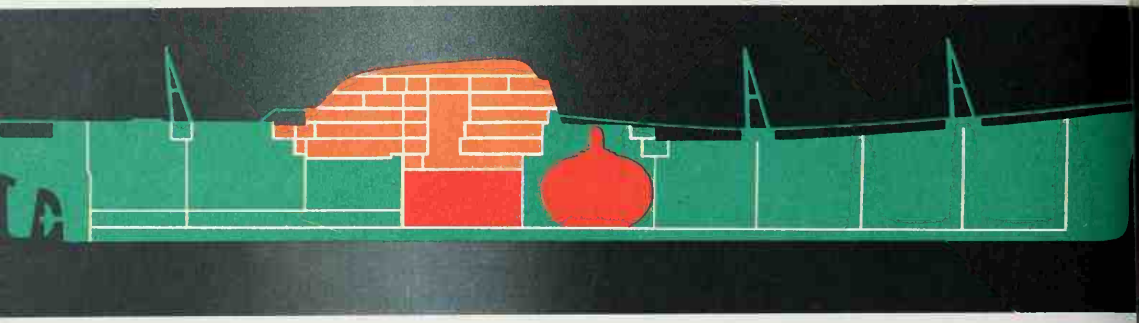


Meanwhile, high above us and barely visible in the sky, the new supersonic transports will flash by thundering and whistling.

Supersonic, in case you didn't already know it, means faster than the speed of sound, and that is how fast these airplanes will travel. Truly transatlantic liners of the sky, the planes of the future will carry over a thousand passengers across the oceans in a few hours. The passengers will be served by a small army of stewards and stewardesses and will be able to take their choice of a dozen different restaurants aboard their flights.

And while we are on the subject of oceans, let's take a look at the ships of the future.

To begin with, you will have to change



Opposite page: The N.S. Savannah, *the first nuclear-powered merchant ship, as seen at night. It is over 650 feet long and displaces some 22,000 tons. Its nuclear engine gives it a range of over 300,000 miles. Above: Drawing of interior of ship. Green area shows cargo capacity. The red is space occupied by nuclear reactor and engine and the conventional engine. Brown area is used by crew, officers, and service personnel. The* Savannah *saw only limited service and is now a floating museum.*

your thinking about what ships can or cannot do, because the ships of the future will not act the way we expect ships to act.

It is true that they will be beautiful and comfortable, but they will also be freed of one great obstacle—water. I know it sounds strange. We have always associated ships with water, but water has always been an obstacle to the amount of speed a ship could attain. This is due to the resistance of the water to the hull, or body, of the ship, which slows it down.

The ships of the future, greatly changed in form and with greater means of propulsion, will free themselves of the water. They will fly *over* it like gigantic sea gulls and swifter than the winds!

How will they do this? Well, to explain that we must return to our old friend the air-cushion. I told you it was a magnificent invention that was going to play an important role in the transportation of tomorrow.

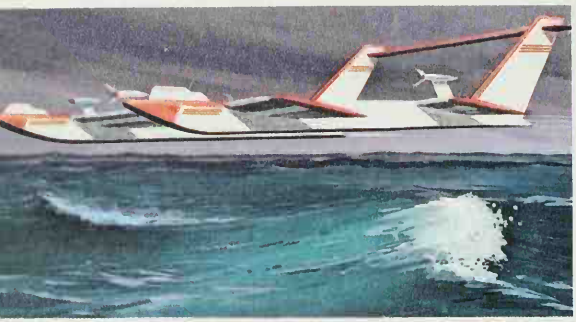
BETTER LATE THAN NEVER

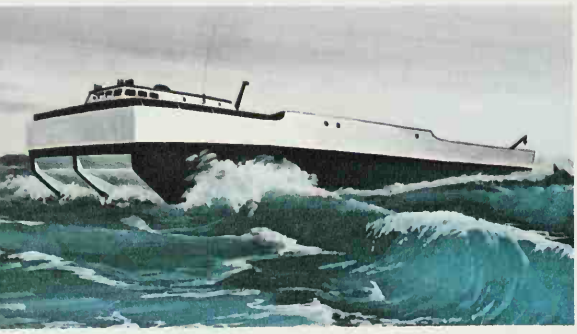
Progress in navigation is now making rapid strides. It is advancing at a terrific rate, perhaps to regain the time it lost as other types of transportation moved forward with new forms and new designs.

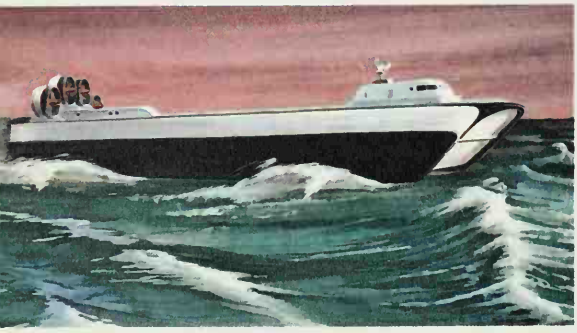
Let's glance back in history for a moment. Thousands of years passed before man first dared venture onto the seas in rafts. Thousands of years more went by before the primitive raft gradually developed into the full rigged sailing ship.

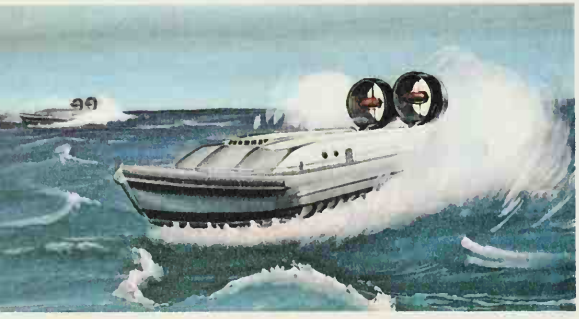
But after only a few centuries—seconds in the course of human history—the sail was replaced by the steam engine, and then steam by more powerful and modern engines.

Let us keep two dates in mind: 1819 and 1959. In the year 1819 the American ship *Savannah* became the first steam









vessel to cross the Atlantic Ocean, making the voyage from the United States to England. In 1959, after years of testing, the United States officially launched the first nuclear-powered commercial vessel. It was also called the *Savannah*, after its famous ancestor.

On its historic maiden voyage in 1964, the *Savannah* was hailed as an engineering miracle. The original *Savannah* took 29 days to make its transatlantic crossing, and the engine was used for only a small part of the voyage. Most of the trip was made under sail. The latter-day *Savannah*, with its nuclear power plant, had a range of over 300,000 miles. To cover that same distance a traditional type of ship would have to use not less than 90,000 tons of fuel!

Well, today, only a relatively few years after its historic voyage, the N.S. (Nuclear Ship) *Savannah* is out of date. It has been laid up and is being used as a museum!

Merchant ships much more powerful and speedier than the *Savannah* are now under construction in shipyards. But power in itself is not enough to overcome the limits on ships as long as water resistance continues to be a problem.

What is the answer to the problem? It's very simple: Just lift the ships out of the water!

The first step in this direction has already been made with the development of the hydrofoil, which is a sort of winged boat. Hydrofoils skim along the surface of the water with only part of the hull submerged, while the rest of the hull is lifted up on the "wings." The water re-

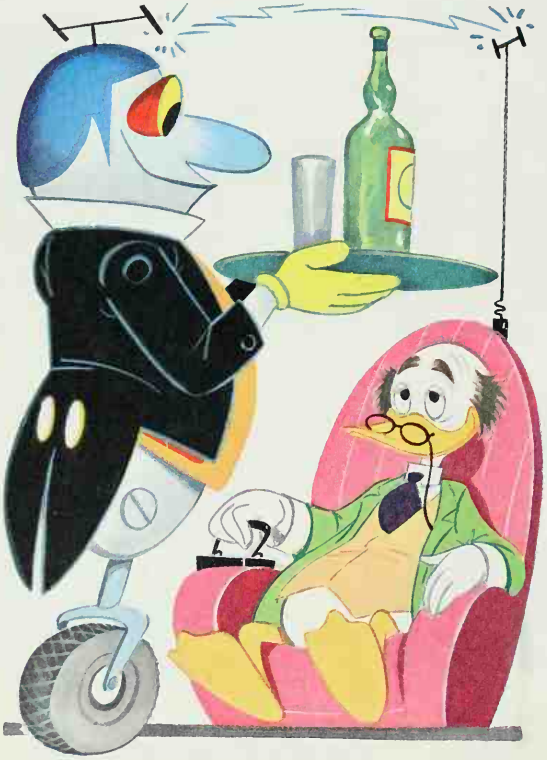
Models of ships of the future, top to bottom: Flying ship, cross between airplane and a ship; next two are ships that operate on the air-cushion principle; a water-cushioned hovercraft. Opposite page: Hovercraft in use today.

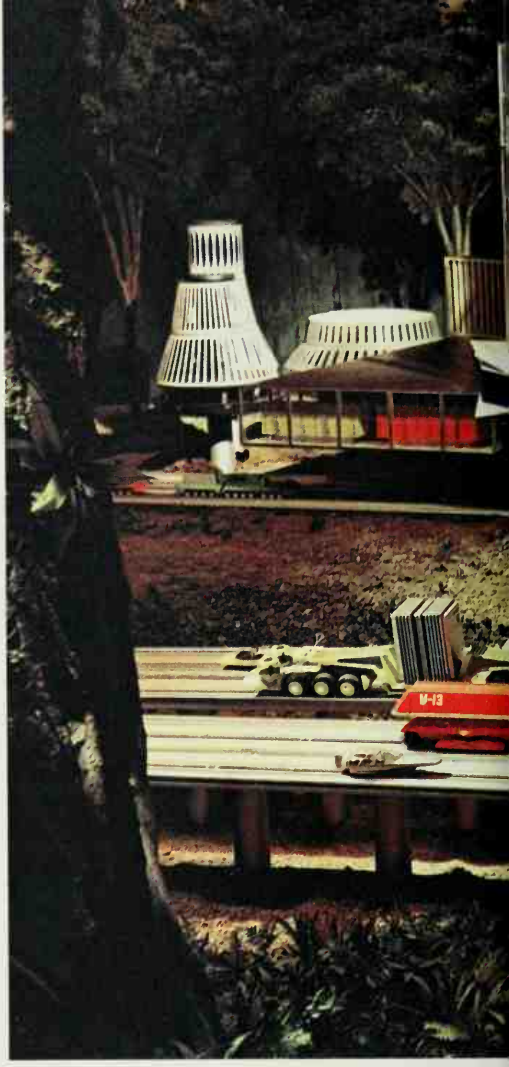
1

sistance is thus lessened and very high speeds may be reached. But complete freedom from water resistance will be accomplished only when ships emerge completely out of the water. This will be possible with the use of air-cushion vehicles.

The first model of the hovercraft was powered by a propeller mounted underneath the vehicle. It blew a strong current of air downward toward the ground. This lifted the vehicle off the surface where it floated on its "cushion" of air. A second propeller, mounted at the rear, provided the forward motion. A special device prevented any of the air from being lost.

Since the early hovercraft experiments, new, speedier, and more powerful models have been developed. One such model is the British SR.N4, which is designed to carry 250 passengers and 30 automobiles





A futuristic model of an outpost located in the heart of a jungle. The outpost is connected with a large city by a highway on which electrically-controlled cars are in operation. A small town containing all the necessary conveniences for the people working in the area has grown up along the highway. The town serves as a processing center for the precious raw materials gathered in the jungle. Here is a fact that you might find interesting: The trees in the model forest have 3,000,000 leaves!

in ferry service across the English Channel.

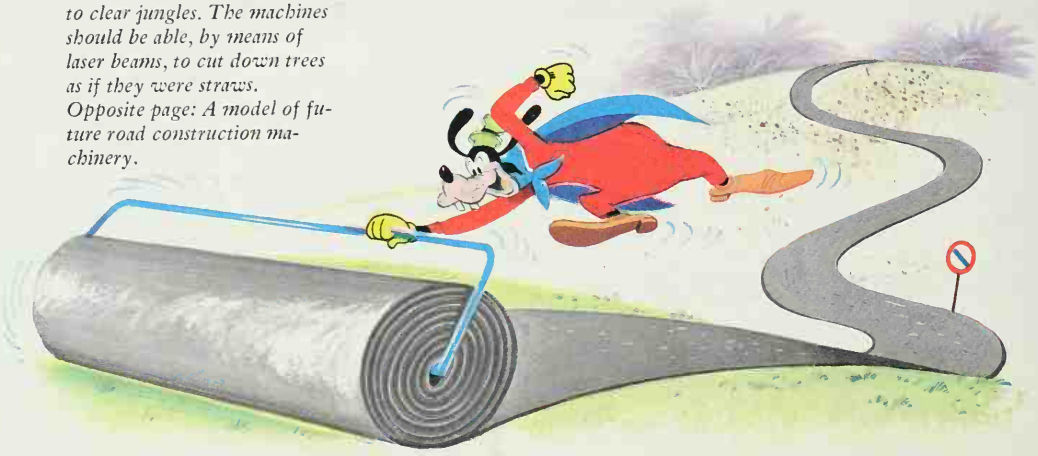
What is especially interesting about this vehicle is that it is amphibious, which means that it can travel equally well over land or water.

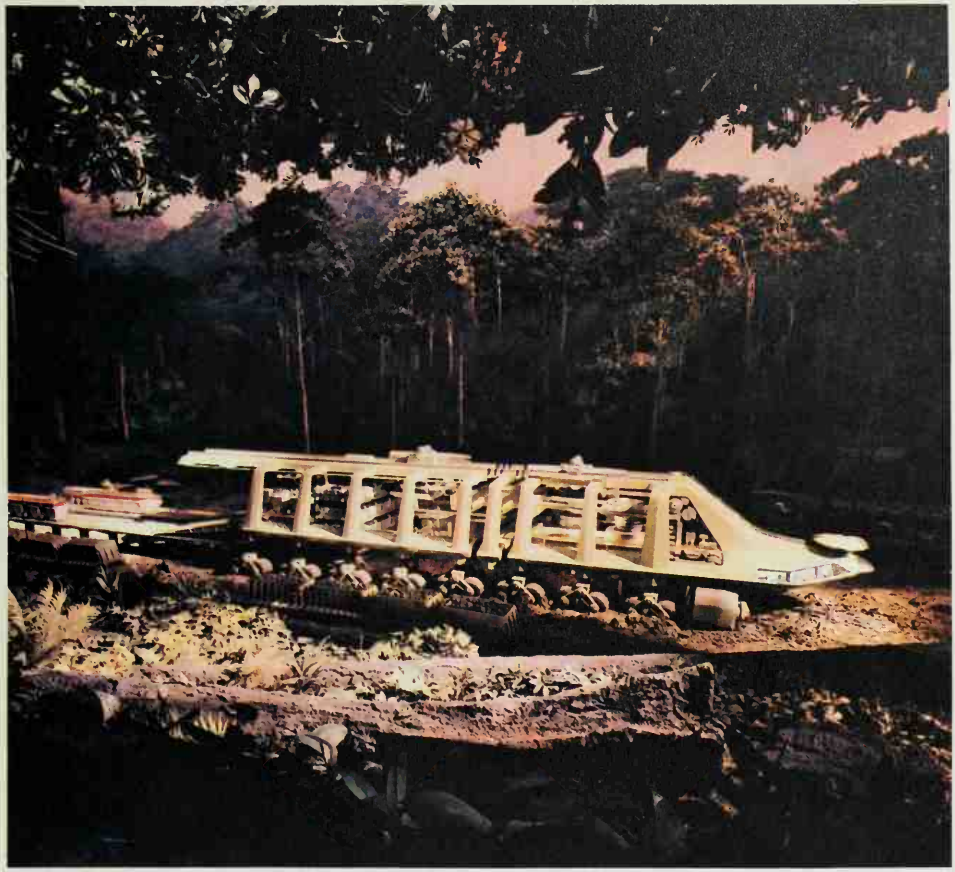
ELECTRONIC AMPHIBIANS

In the not-too-distant future, a new type of vehicle should be added to our many methods of transportation: the land cruiser. Or we might call it a sea train. The land cruiser will be capable of carrying 1,000 passengers.

Without wheels and flying on a cushion of air, it will be able to take off from a seaport or a station on land. It will skim over plains, farmland, lakes, and rivers at a speed of almost 500 miles an hour. At this rate of speed, a person can travel from Rome to London in about 3 hours.

Above: Small models of machines man may use in the future to clear jungles. The machines should be able, by means of laser beams, to cut down trees as if they were straws.
Opposite page: A model of future road construction machinery.





The land cruiser will also be able to follow regular routes across the oceans.

At any rate, these are the plans. But until the large land cruiser is ready, we will have to be content with smaller models, which are already far along on the drawing board. These hovercraft are planned to float about 15 feet above the surface of the water. This height is needed to avoid the high waves that an angry sea churns up during a storm.

I'm sure you've seen pictures of storms at sea when foam-edged walls of water rise high in the air and come roaring down. Picture what would happen if a hovercraft cruising at about 250 miles an hour should bump its unfortunate nose against a wave 50 feet high! I wouldn't want to be a passenger, would you?

If a regular transoceanic hovercraft service is ever to be established, the problem of achieving safe cruising heights is one that will have to be solved. Once this is done, man will have at his disposal a great many kinds of transportation. These will allow him to travel speedily from one point on the globe to another. And at what a saving of precious time!

But finding ways to save time is not the only challenge that faces us. In order

to live an ideal life, future generations must also solve the problems of finding food and living space.

A HOUSING PROBLEM

I think I've already told you the population of the world is expected to reach 7,000,000,000 (billion) by the year 2000, and to go on increasing after that. Now, all of these people will need a place to live.

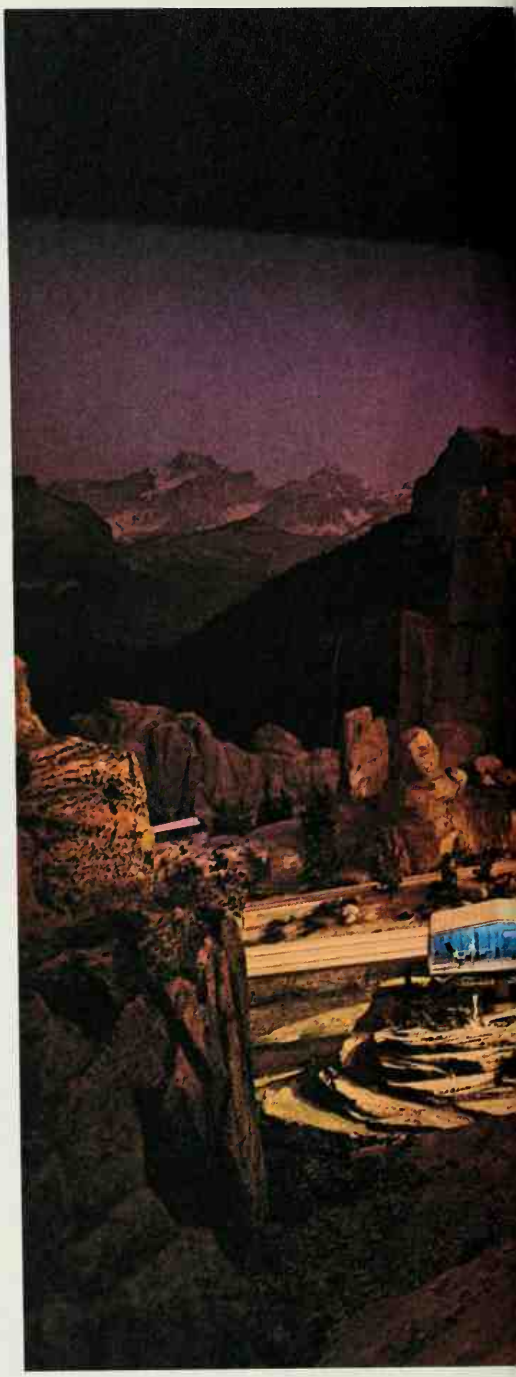
As you know, the earth's surface is as big as it is. It can't be stretched like a rubber band. Actually, as the population grows, there will be even less useful land available. Vast areas will have to be set aside for farming, cattle-raising, and giant factories.

Well, then, my friends, where in the world will we find room to build our cities? On the moon perhaps? Come to think of it, the moon can now be reached from the earth, no one lives on it, and it is surely big enough to house millions of people.

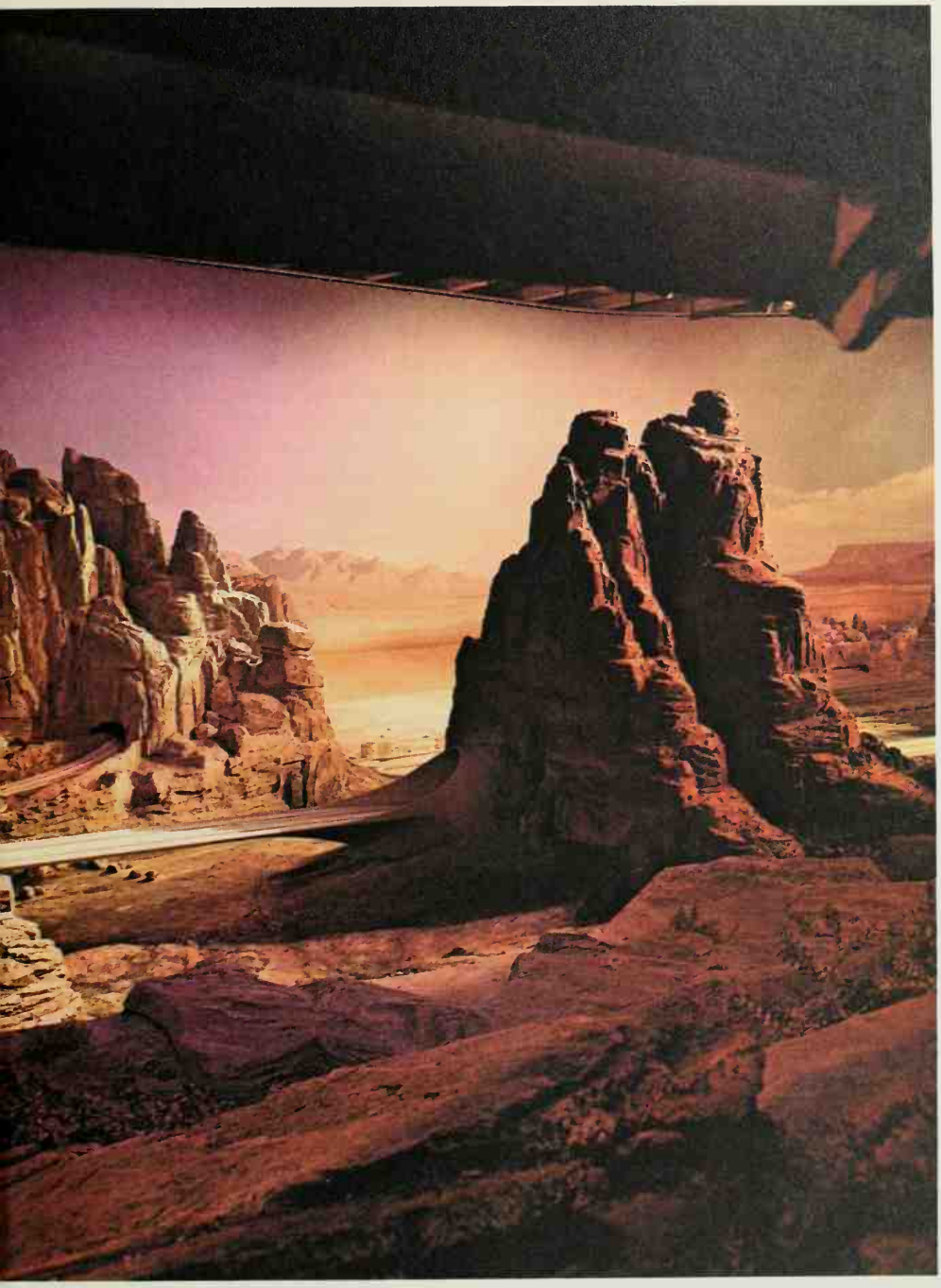
But . . . but . . .

CITIES UNDER GLASS

But in order to survive, man must live in an environment similar to his environment on earth. There must be air for him to breathe, enough water for his needs, and temperatures somewhere between 40 degrees below zero and 130 degrees above zero, Fahrenheit. The moon cannot offer all these wonderful and necessary things to future moon-dwellers.



Man should be able someday to conquer the desert, as well as the jungle, turning what are now vast empty acres into productive land. The model scene looks ahead to a time when people will live in desert homes, designed to rotate slowly, following the movement of the sun in the sky.



Someone had figured that the problem could be solved through underground dwellings, or habitats. These would be protected against fiercely cold or fiercely hot moon temperatures, and would have all the equipment necessary for producing and replacing air and water.

But I think someone must be joking. Are we going to send men back to the life of prehistoric cave-dwellers? No, people may be able to live on the surface of the moon, under enormous tents of transparent plastic material. Air could be supplied by means of gigantic tanks of liquid oxygen, sent from earth, or it might be recycled by some chemical process.

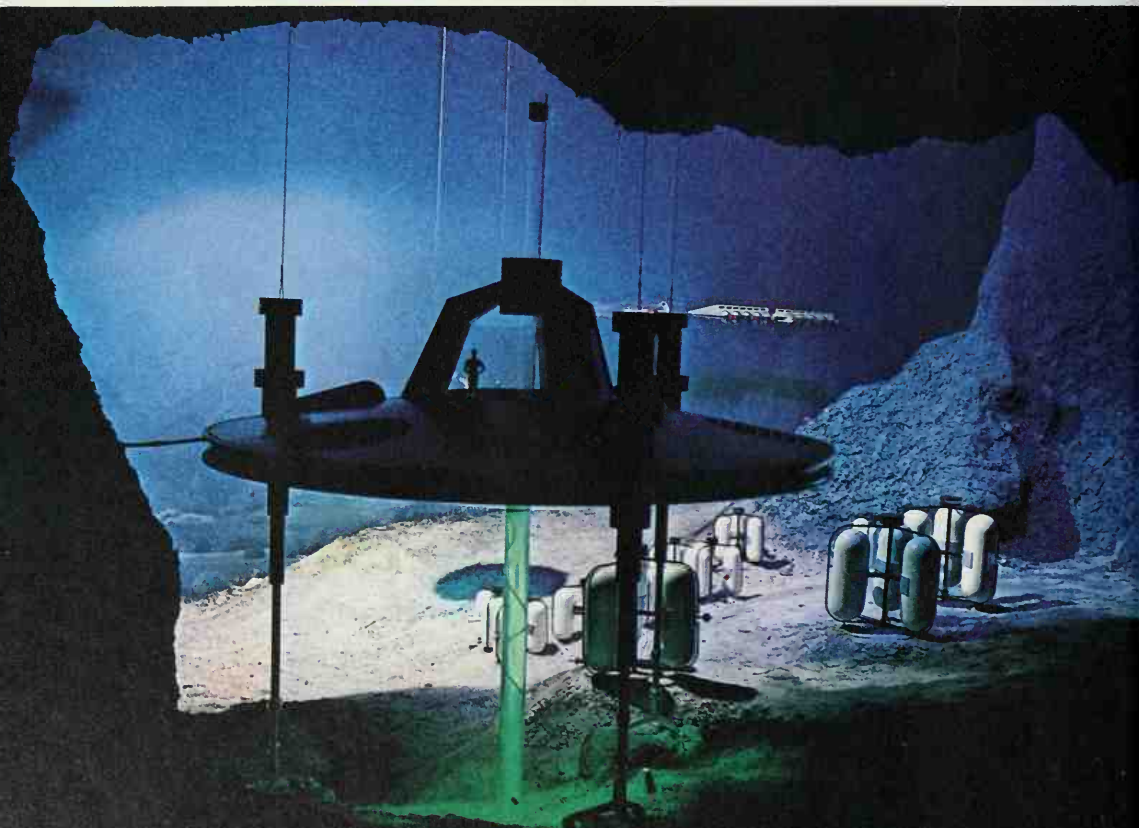
Under the huge tent, buildings, streets, flower gardens, and vegetable plots would appear. The garden plots would be planted in the lunar rocks, with water and fertilizer added. Water could be obtained from these rocks through special heating or chemical processes.

The energy necessary for all this, as well as for light, air-conditioning, and other needs, would be furnished by nuclear power stations.

It may well be that beneath the lunar surface large water supplies are concealed, like the springs of water under the deserts on earth.

It may be possible to produce fresh vegetables from plants grown by the hydroponic method. In this method, plants grow in large tanks of water, instead of in soil. The water contains solutions of all the chemicals needed for plant growth.

Plants called algae, which include sea-



weed, are rich in protein. It may be possible to grow these on the moon. Already scientists on earth have grown an alga, Chlorella, in tanks of water. Using algae as a protein food is an idea that has been tried with good results. In Japan, for example, people eat seaweed cookies and even seaweed ice cream.

The colonization of the moon seems possible, even though we may have to wait many decades or even several centuries before all the problems are solved. Certainly I have to smile when I think of the children of possible future generations, born on the moon of parents who were also born there. These children will watch the earth rise and set in the sky, and probably ask if it is inhabited by earthmen or if it was settled by ancient lunar astronauts.

Yes, my dear earth children, the far-off future holds many surprises! Meanwhile, let's see what we can do about housing the people of the year 2000.

AT THE BOTTOM OF THE SEA

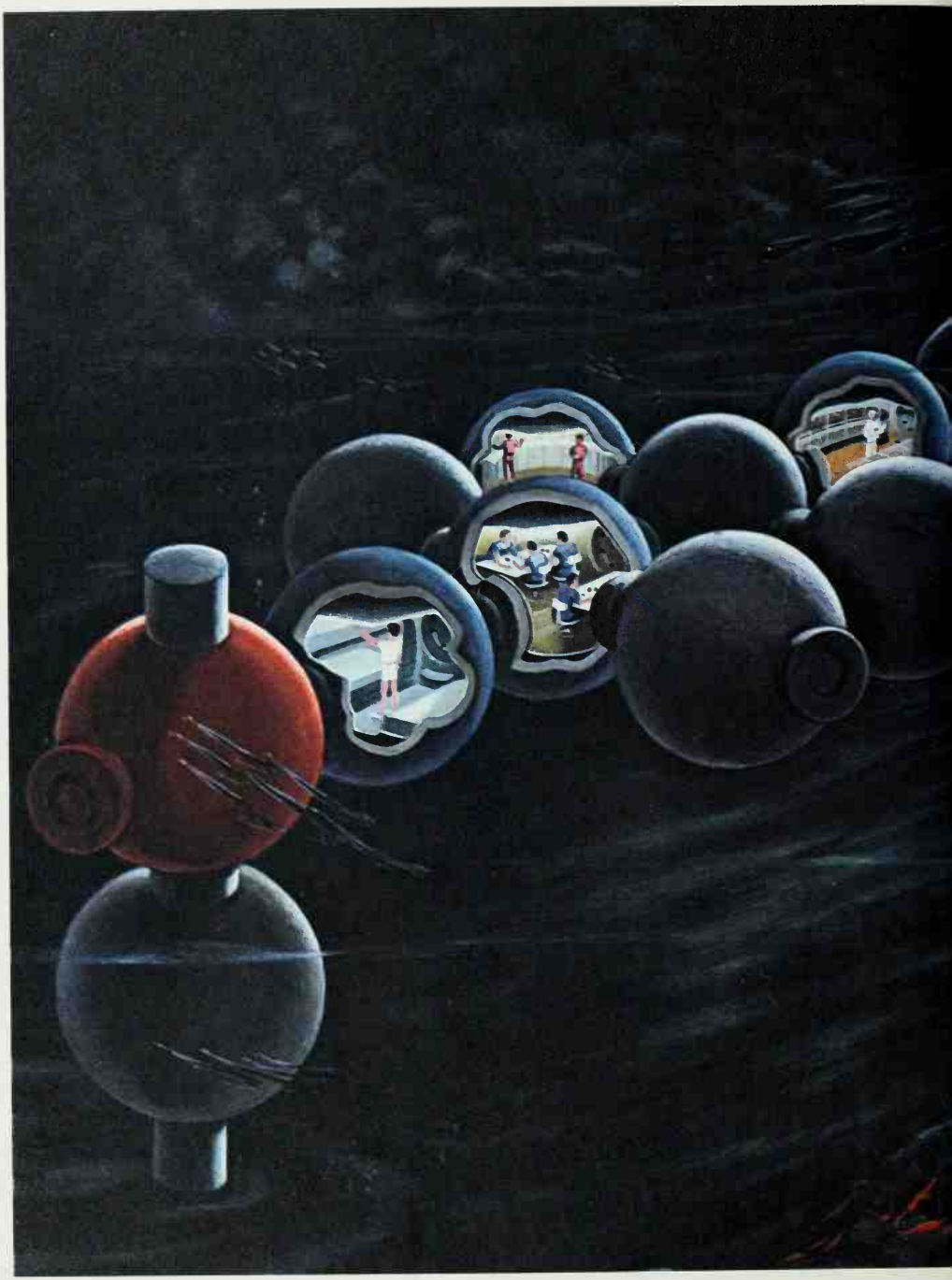
What did the pirates and buccaneers do long ago when they had too many prisoners aboard their vessels? They tossed them into the sea, and that was that!

Well, we may end up doing the same thing, only with kinder intentions. We may solve the problem of overpopulation by building underwater cities.

Naturally we will have to proceed gradually. In the beginning we may send

Opposite page: A model of an oil drill that may be used sometime in the future in hunting for oil beneath the sea. Almost three quarters of the earth's surface is covered by water. Immense mineral wealth, including oil, lies beneath the sea. Therefore, it is likely that oil drills will be among the first underwater structures to be built.

Above: The desert as it may look in the decades ahead. In this model plan the tower in the foreground serves as the control center for electronic equipment. Water would be carried by pipeline from the sea, treated to remove the salt and used for irrigation. Express highways would link the homes of desert pioneers to large cities.



squads of workers to the ocean floor to take charge of the large-scale production of fish—from supervising the fish-herders (the dolphin boys) of the ocean range to canning fish and making ready-to-eat protein flour.

Other workers may be employed in factories turning seaweed into highly nourishing food for the use of people living on the surface. Then the technicians and miners will have their turn.

On the bottom of the sea there are big stretches of bulb-shaped mineral deposits. Some are as big as potatoes and some are as small as grapes. These rounded forms are really small masses of minerals, including manganese, an important element in the making of steel. It is estimated that there are enough of these deposits to permit taking out trillions of tons of minerals from the ocean floor.

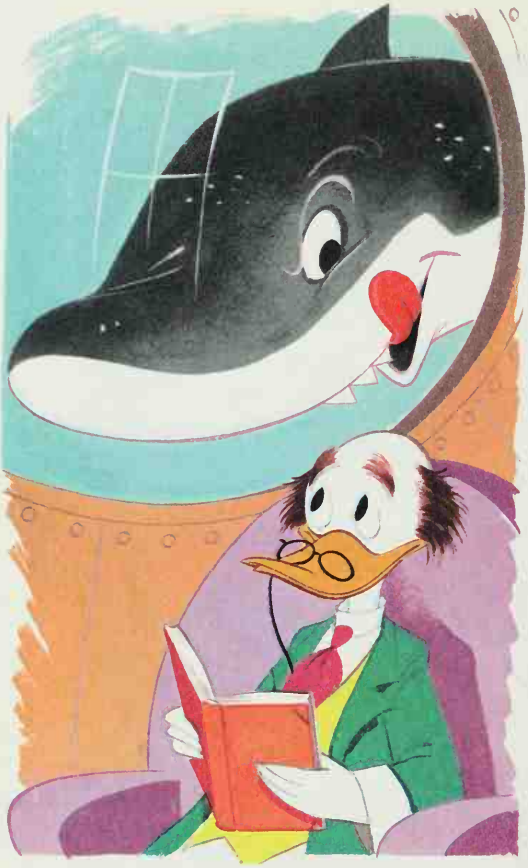
Why, then, should we leave these deposits on the bottom of the sea, since in the very near future nuclear energy should allow us to harvest them? (The day hasn't yet come, however.)

This same nuclear energy may furnish air, drinking water, light, and everything necessary to the lives of the ordinary citizens who should make up the third wave of underwater colonization.

A NEW WORLD UNDER THE SEA

Plans to make the ocean habitable, to explore the depths, and to develop their immense resources have already been drawn up by a number of specialists. One of the most carefully thought out of all

After man has explored the ocean's depths, the time may come when he will live in underwater habitats, or dwellings. The project illustrated here was drawn up by General Electric engineers.



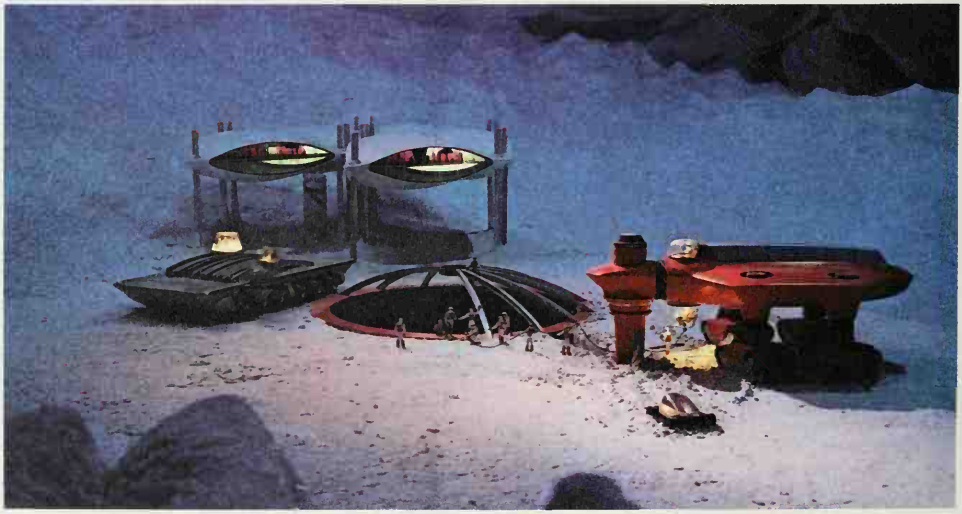
these projects was the work of a group of engineers of General Electric, working with United States Navy experts.

This project, known as Bottom Fix, envisioned the construction in the future of a real underwater city, made up of sections that could be joined to one another easily, like the parts of one of those construction sets you boys and girls enjoy so much.

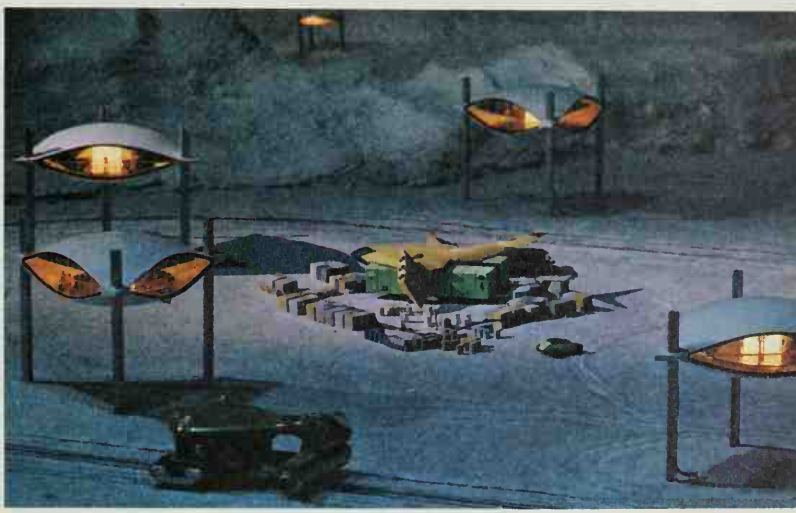
The various parts were to be carried, one at a time, by special submarines, to the building site more than 13,000 feet below the surface. The sections of the buildings the engineers proposed were to be spherical in shape and each section was to have a specific use (bedroom, living room, kitchen, bathroom, and so on). Communications between the sections were to be through watertight doors.

Once man is able to build the first underwater houses, it should then become possible for him to build entire underwater cities, with offices, restaurants, hotels, movies, and schools.

Schools? Yes, boys and girls. Because if the science and technology of tomor-



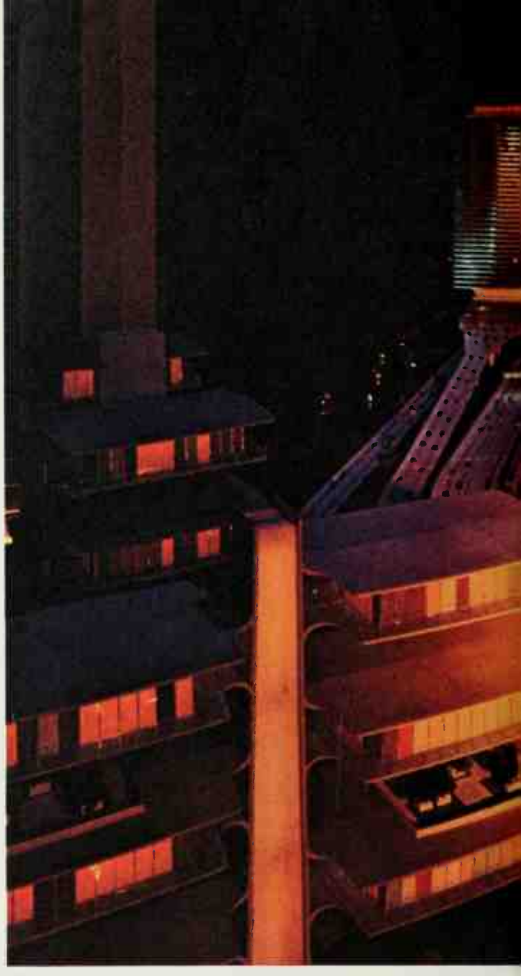
Above: An underwater resort, imaginary now, but possible in the future. The resort is a two-story motel anchored to the ocean floor. Tiny two-seater submarines are intended to come and go from the first floor. They are for use by the guests for underwater tours. On the upper floor are rooms for guests and a dining room.
Opposite page and below: Two views of an Antarctic base as it may look in the future. The buildings are streamlined to offer less resistance to the wind, and they are raised from the ground to prevent their being snowed in. On the opposite page technicians complete the building of a depot for the storing of supplies and equipment.



row put at our disposal electronic equipment—robots to do our housework and to do the heavy work in factories—we must never lose sight of one fact. These and other miraculous marvels exist only because human skill conceived them, built them, and made them operate. These robots will even build other robots and repair them, if we so desire, but they can never replace that marvelous and irreplaceable device—the human brain.

The man of the future runs a risk that I am sure you boys and girls have already thought of: the loss of liberty, or more exactly, the liberty of being himself. In contact with the new space or underwater civilizations, man will be forced to change his habits and perhaps even his physical appearance.

I'm not mentioning the possibility that the great machines man has invented may one day disobey and take over, rebelling against the orders of their masters. Certain films and science-fiction stories have



The cities of the future will stand out against the night sky with countless dazzling lights. In the centers of cities, goods may be distributed by means of conveyor belts. Luxurious apartments may be suspended in space, held by a single support.

already looked ahead to such a possibility.

But don't be alarmed, my friends. I have faith in you and in those who will come after you. In other words, I have faith in man.

Man and man alone can and must be the maker of his own future. If man were not capable of facing and solving the most difficult problems, all of us today would still be living like people in prehistoric times, to the great discomfort of humanity in general, and of yours truly in particular, since I love an easy life.

I certainly do love an easy life. As a matter of fact, for the last few minutes I have been looking longingly at my faithful old armchair. I can hardly wait to stretch out in it and daydream about a future world in which no one will suffer from hunger and everyone will have a home, built on the earth's surface, in the ocean depths, or under a dome on the moon.

I, therefore, hasten to conclude this volume, especially since I have no more room. Let me just say greetings and futuristic best wishes to all.

So long, friends! Your ever most affectionate Professor Ludwig von Drake.

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Note: Page numbers in italics refer to pictures.

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